Platform Architecture Report:

Recommendations to the Information Technology Investment Board and the Architecture Review Board

Version 1.0, December 20, 2003

Prepared by:

Virginia Information Technologies Agency
Strategic Management Services Directorate
Policy, Practices and Architecture Division
Platform Domain Architecture Team

(This page is blank, intentionally.)

Platform Architecture Creation and Review

Virginia Information Technologies Agency (VITA) Platform Domain Team Members

Chris Williams .....VITA, Customer Support Services
Brian Epley .....VITA, Business Systems
Dave Kiser .....VITA, Computer Services
Deborah Lewis .....VITA, Computer Services
Dave Matthews .....VITA, Computer Services
Cindy Bryce .....VITA, Computer Services
Karen Lusk .....VITA, Computer Services
Sam Murdock.....VITA, Computer Services
Diane Wresinski (Domain Team Facilitator).....VITA, Strategic Management Services

Strategic Management Services Review

Jerry Simonoff, the Director of Strategic Management Services within VITA, and Paul Lubic, the Policy, Practices and Architecture Manager within Strategic Management Services, provided the initial review of the domain team's report.

VITA Directors' Review

VITA directors reviewed the Platform Architecture draft prior to its release for the 30-day online review. This review constituted the first review by the Architecture Review Board

Agency Online Review

Participation of all agencies was encouraged through an on-line review and comment period of 30 days. The review period was extended an extra week at the request of one agency.

Review by Technology Businesses and the Public

Technology businesses were actively encouraged to use the online review and comment tool or to provide comment by other means.

Reviews by the VITA Architecture Review Board and the Information Technology Investment Board (ITIB)

The recommendations in this document divided into two groups for approval. The ITIB approves the more significant technical recommendations and the Architecture Review Board approves less significant recommendations and those that are operational in nature.

(This page is blank, intentionally.)

Table of Contents

Tables and Figures

(This page is blank, intentionally.)

Executive Summary

This report addresses platform architecture recommendations for Virginia's agencies[1, 2]. The Platform Architecture is part of Virginia's Enterprise-wide Technical Architecture (EWTA). The EWTA addresses the information technology requirements implied by the Commonwealth's business strategies. The EWTA reports recommend technologies, policies, standards, and best practices for Virginia's agencies.

The Platform Architecture Report is written to assist business and technical leaders in state agencies and in central services in making sound decisions related to platform design and acquisition. The document was drafted by the platform domain team, which was commissioned to provide platform-related recommendations for review by the Information Technology Investment Board (ITIB).

The domain team identified personal computers, servers, and storage as the most important topics to be reviewed within the scope of this report. Addressed within each platform topic is the software required to provide an operational platform. The domain team also recommended the inclusion of printers as a topic for later consideration.

In general, the Platform Architecture Report provides guidance and information to executive branch agencies through the following content:

- Overviews of three technical topics: personal computing, server, and storage platforms
- Recommendations that agencies deploy technologies rated as "Strategic"

  (These ratings are presented within each technical topic in tables, which begin on the following pages: personal computing devices, page 14; servers, page 39; and storage, page 64.)
- Identification of related laws, executive orders, and existing Information Technology Resource Management (ITRM) Policies, Standards, Guidelines (PSGs).[3]

[1] This report provides hyperlinks to the Glossary in the electronic version. In the electronic and printed versions, the hyperlinks will have the appearance established by the preferences set in the viewing/printing software (e.g., Word) and permitted by the printer. For example, the hyperlinks may be blue and underlined in the screen version and gray and underlined in the printed version.

[2] The Glossary entry for agency is critical to understanding recommendations in this report and is repeated here. Agency–generally means executive branch agency, which includes higher education agencies; however, due to confusion introduced by scope restrictions on selected responsibilities of the newly created Virginia Information Technologies Agency (VITA), recommended requirements in this report will apply as follows. Tabled technology acquisition and use requirements in this report will apply to all executive branch agencies including the administrative units of higher education. Recommended requirement statements will apply to higher education administrative units only if so noted within the statement.

[3] Some IT policies come about as a result of laws written by the General Assembly or Executive Orders issued by the Governor; other IT policies are ITRM policies, standards and guidelines, which are developed by the Virginia Information Technologies Agency as recommendations to the Secretary of Technology, the Chief Information Officer and the Information Technology Investment Board.

- Proposed technical requirements and best practices to be reviewed by the ITIB and then, with Board approval, converted into official ITRM PSGs

  (The summary of recommendations to the ITIB begins on page 87.)

- Proposed operations requirements and best practices to be reviewed by the Architecture Review Board and then implemented as funding and staff resources are identified.

  (The summary of operations recommendations begins on page 93.)

- A Glossary of technical terms

  (The Glossary precedes the Appendices.)

- Web links provide additional information resources for selected technologies

  (These links are provided in the glossary and throughout the document.)

For personal computing devices, the general approach recommended is one of strong central control. Controls are proposed for the following areas: hardware acquisition, desktop display replacement, operating systems, productivity software, antivirus software, email services, and desktop management. Also recommended are twice-annual reviews of hardware specifications for desktops, laptops and PDAs.

Cost and benefit analyses, service and service use metrics, assessments of agency business needs, special study results, and other data are to play a very important role in the ongoing decision process for personal computing. For example, the report recommends continued use of the Microsoft Windows operating system and Office Professional suite until a comprehensive study of alternatives can be conducted. The results could be used in price negotiations with Microsoft and in reconsidering the future directions for personal computing. Sun's Java Desktop is an example of one alternative environment that could be evaluated. A different Microsoft environment (e.g., deployment of Office 2003) might also be considered.

A centrally controlled approach to providing email to desktops and PDAs is recommended including the use of Blackberry devices and services for workers who need remote email access. For support, location-based services are recommended. The standardization proposed for personal computing is expected to lower costs, improve support, improve personal computing tool uniformity, and improve services availability for the Commonwealth's workforce.

For midrange to low-end servers (i.e., servers that often cost less than $50,000), standardization of operating systems is recommended when servers provide specific functions that are good targets for consolidation. Operating systems standardization will aid server consolidation efforts both of systems that are to be operated locally but managed centrally and of systems that are to be moved to a consolidation configuration such as a scale out or scale up solution in the data center. Server consolidation projects recommended for initial consideration include email consolidation and file server solution alternatives.

Server recommendations specifically promote the appropriate use of Windows and Linux operating systems for the midrange to low-end servers that provide network, file, print, email and web site services. Recommendations also require that agencies and central services

examine storage alternatives before acquiring new file servers. Hardware standardization by competitive bid is recommended for low-end servers. Also on the low-end, appliances are encouraged as options as are proven blade server solutions and high-density racks.

For the midrange and high-end UNIX servers, the Sun Solaris solutions, Hewlett Packard HP-UX solutions and the IBM zOS solution are recommended. Hardware components from any manufacturer that will run applications without change and provide equal or better performance are candidates in new acquisitions or for parts. For any application needing high-end performance, the report recommends that decision makers consider all three platforms alternatives.

Midrange to high-end servers that use Intel and AMD chipsets (e.g., Itanium 2 and Opteron) will compete with similar in-architecture UNIX and IBM servers in the near future. At present, the operating systems (e.g., Windows 2003 Enterprise and Datacenter versions) still have a shallow installed base and may lack a track record for comparable uses. These combined solutions may enter the equation by 2005 as more applications that use the 64-bit architecture are available.

Virtual server technology is expected to play a significant role in Virginia's consolidation solutions. However, virtual servers created by software including Connectix, VMware, and VM should run operating systems that are in Virginia's architecture or past versions of them.

The ability to grant exceptions to operating systems standards will be critical, especially for servers that support business applications. Agencies that are examining proven applications developed for other states, for example, may need an exception if the application has been proven only on one platform. Applications should be migrated from existing platforms only when it is cost-effective to do so or when the manufacturer has scheduled the platform for obsolescence (i.e., has eliminated support).

Over time, the target server architecture changes in Virginia will result in:

- Fewer servers
- Fewer locations
- Better service with fewer staff (e.g., for backup provision)
- More high density solutions
- Increased reliance on telecommunications
- Movement of databases to separate platforms or to separate partitions on the same platform
- Fewer operating systems
- Increased use of scale-up and scale-out consolidation solutions
- Scalable server solutions for utilities including email, web page serving, and storage
- Use of virtual servers for development and some testing
- Tracking data on architectural patterns by application
- Tracking of planned retirement dates for applications and for server hardware
- Increasing use of Linux
- Managed increases in uses of Solaris and HPUX
- Decreasing use of Windows where Linux is used
- Managed decrease in the use of all platforms not in the architecture
- Managed increase in use of platforms in the strategic architecture
- Eventual use of Windows as a consolidation platform
- Continued use of commoditized hardware at the low and low-midrange server end
- More consistent product life-cycle management
- Continued acquisition of high-end platform

- Use of virtual servers for accommodating multiple versions of an OS as a transition strategy for consolidation of a network function
- Use of appliances for functions including cache, storage, etc.
- Use of stored images for rapid provisioning changes to clusters
- Active consideration of "within-architecture" platform alternatives for all new and revised business applications
- Tracking of staffing requirement issues related to each operating system supported

capacity when it is needed (e.g., for processor activation, processor acquisition, etc.)

- Having lease lengths that match anticipated technology life
- Movement to consolidation platforms only if cost effective (effectiveness assessments include consideration of the value of all benefits such as security, customer service improvements, and other consolidation benefits)
- Consideration of platform outsourcing if all applications remaining on an "out-of – architecture" platform custom-coded applications with low availability or use needs.

For storage, the recommendations emphasize the importance of capacity and storage planning by agencies and by data center application service units. This planning data is critical for determining workable solutions across applications and across agencies. Also, storage decisions will be a critical component of function-based server consolidation efforts including email and file server solutions.

Within most of the smaller agencies, existing direct attached storage (DAS) and file servers may be adequate to address storage needs well into the future. However, the consolidation of management and support for storage may be cost beneficial even for these DAS solutions and file servers.

For agencies with greater storage requirement, within agency network attached storage (NAS) solutions may be appropriate. Only in those agencies with very massive storage requirements will storage area networks (SANs) be cost effective. The present high cost of SANs is mainly related to the Fibre Channel technologies that are currently used to connect servers and storage. New technologies including Ethernet SAN switches and the iSCSI transmission protocol will become a proven alternative to Fibre Channel in the near future. This will make SANS a more affordable alternative for meeting a greater portion of the Commonwealth's storage needs. These two new technologies will open doors for centralized storage solutions that are cost effective for all agencies.

For all central consolidation and central management endeavors, whether for desktops, servers, or storage, this report emphasizes the importance of well-planned networking components. To the extent possible, all future network improvement plans, especially in the Richmond area, must take into account not only present agency needs, but also future directions in platform infrastructure. This report also stresses the need for data-driven decision making. Quality data on existing platforms and agency business needs supplemented by well-documented studies of alternatives will be key to choosing appropriate platform solutions.

Platform Domain Team Mission

The Platform Domain Team's mission is to recommend Commonwealth policies, standards, and best practices for personal computing, server, and storage platforms. The team will address platform components related to productivity software needs for individuals and workgroups, and business information processing needs for the enterprise. Team recommendations will promote efficiency and effectiveness and will support the meeting of business continuity, security, and privacy needs.

(This page is blank, intentionally.)

Background

Virginia's Enterprise Architecture (EA) includes business, governance and technical components that describe how Virginia will use technology and proven practices to improve the way it does business. Jointly, the technical components are referred to as the Enterprise-Wide Technical Architecture[4] (EWTA). EWTA is comprised of eight technical domains. EWTA constitutes a comprehensive framework for providing technical guidance and related best practices to Virginia's central services and individual agencies.

The EWTA is being developed in stages and will be updated routinely. Enterprise Architecture development and revision teams began their efforts by specifying business strategies and information requirements, which were used to identify changing expectations for Virginia's future enterprise architecture. The following diagram summarizes the development process.

Figure 1: Development of the Enterprise-Wide Technical Architecture (EWTA)

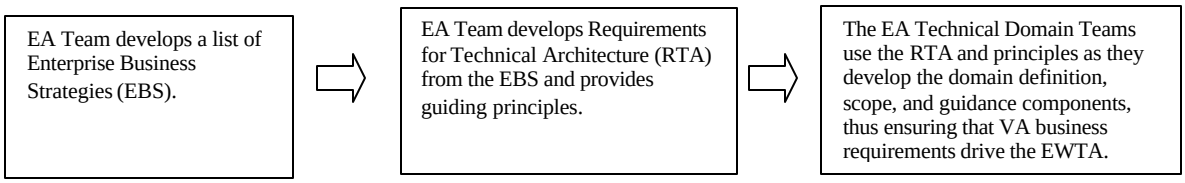


Table 1: Virginia's EWTA Domains

Base	Functional Glue	Application
Network Architecture Platform Architecture	Middleware Architecture	Systems Management Architecture Database Architecture Application Architecture Information Architecture
Security Architecture		

Virginia's eight technical architecture domains are listed in Table 1. Each of the eight domains is a critical piece of the overall architecture. The Network and Platform Domains address the infrastructure base. These two areas provide the foundation for the distributed computing architecture. Systems Management, Database, Application, and Information Domains provide vehicles for discussing the business functionality and management of systems and resources. The Middleware Domain addresses the interfacing of disparate platforms, systems, databases and applications in a distributed environment. The final domain is the Security Domain, which is related to all other technical domains and which

[4] This report provides hyperlinks to the Glossary in the electronic version. In the electronic and printed versions, the hyperlinks will have the appearance established by the preferences set in the viewing/printing software (e.g., Word) and permitted by the printer. For example, the hyperlinks may be blue and underlined in the screen version and gray and underlined in the printed version.

goes beyond technology to addresses governance issues. These eight domains provide a useful way of communicating guidelines, policies, standards and best practices of the EWTA to stakeholders in state and local government agencies and state institutions of higher education.

This report addresses only the Platform Architecture, which is a base component of the EWTA. The report provides guidance regarding systems hardware, operating systems, basic software, and systems interfaces. The report also contains recommendations to the ITIB for components of future Information Technology Resource Management (ITRM) policies, standards and guidelines (PSGs).

The audiences for the resulting Platform Domain Architecture Report are the business and technical leaders in state and local agencies including institutions of higher education and agencies from all branches of government. The information is intended to provide assistance beyond the agencies for which ITRM policies and standards are mandatory. This information will also assist those who make procurement decisions related to desktops, handheld computers, and systems processing equipment.

Throughout this document, the terms "Obsolescent, Transitional, Strategic, and Emerging" as defined below are used to provide guidance regarding how specific technologies are used in the Commonwealth.

- **Obsolescent**-The Virginia Enterprise Architecture actively promotes use of a different technology. Agencies should not plan new deployments of this technology. Agencies should develop a plan to replace this technology, if in use. This technology may be waning in use or no longer supported.
- **Transitional**- The Virginia Enterprise Architecture promotes other standard technologies. Agencies may use this technology as a transitional strategy while moving to a strategic technology. This technology may be waning in use or no longer supported.
- **Strategic**-The Virginia Enterprise Architecture promotes use of this technology by agencies. New deployments of this technology are recommended**.**
- **Emerging**-The Virginia Enterprise Architecture promotes only evaluative deployments of this technology. This technology may be in development or may require evaluation in government and university settings.

In general, the Platform Architecture Report provides guidance and information to executive branch agencies through the following content:

- Overviews of three technical topics: personal computing, server, and storage platforms
- Recommendations that agencies deploy technologies rated as "Strategic"

  (These ratings are presented within each technical topic in tables, which begin on the following pages: personal computing devices, page 14; servers, page 39; and storage, page 64.)

- Identification of related laws, executive orders, and existing Information Technology Resource Management (ITRM) Policies, Standards, Guidelines (PSGs). [5]
- Proposed technical requirements and best practices to be reviewed by the ITIB and then, with Board approval, converted into official ITRM PSGs

  (The summary of recommendations to the ITIB begins on page 87.)
- Proposed operations requirements and best practices to be reviewed by the Architecture Review Board and then implemented as funding and staff resources are identified.

  (The summary of operations recommendations begins on page 93.)
- A Glossary of technical terms

  (The Glossary precedes the Appendices.)
- Web links provide additional information resources for selected technologies

  (These links are provided in the glossary and throughout the document.)

Within this document, when the term "agency" is used as part of a proposed requirement, it refers to Commonwealth of Virginia executive branch agencies and administrative units of institutions of higher education. For the purpose of this document, any academic "instruction or research" infrastructure that can be isolated from "administrative and business" infrastructure is considered exempt from the recommended architectural requirements.

Concerning local governments and other public bodies, while they are not generally required to comply with ITRM policies and standards, their compliance would be expected for participation in technology components of state programs.

[5] Some IT policies come about as a result of laws written by the General Assembly or Executive Orders issued by the Governor; other IT policies are ITRM policies, standards and guidelines, which are developed by the Virginia Information Technologies Agency as recommendations to the Secretary of Technology, the Chief Information Officer and the Information Technology Investment Board.

(This page is blank, intentionally.)

Methodology

The platform domain team began its work by defining platform architecture, and by delineating the team's goals, objectives, and scope of work. Discussions included how the platform domain interfaces with other architecture domains, the present and future directions for platforms, and how often the information provided in this document is to be updated. The team also reviewed input from publications and individuals with specialized knowledge. The results of the team's efforts and deliberations are provided throughout this document.

Platform Architecture Definition

The Platform Architecture defines the personal and business computing hardware systems to be used by agencies. The platforms may include servers (e.g., high-end servers and midrange to small servers), storage systems, personal computing devices (desktops, notebooks, and hand-held computing devices), and other hardware (e.g., printers). In addition to platform hardware, the Platform Architecture addresses operating systems, configurations, network and device-to-device interfaces, and selected peripherals (e.g., floppy drives). In the instance of personal computing devices, the architecture also addresses base productivity software, security software, and utilities that are necessary to make the hardware useful to users. The architecture addresses decision criteria and best practices for the acquisition and deployment of platforms. The architecture also identifies management and remote access components, which are critical to platform use. Details regarding management components are addressed in the Systems Management Domain.

Objectives

The domain team has addressed the following objectives in its initial work and will continue to do so during periodic reviews.

- Provide comprehensive coverage of trends, topics, issues, and critical information needs for personal computing, servers, and storage to guide VITA staff and agency-level decision makers.
    - Provide technology discussions that are understandable to audiences with varied technology expertise.
    - Provide thorough discussions of issues.
    - Improve future data availability for decision making by ensuring recommending appropriate data collection to address relevant questions.
- Recommend requirements to the ITIB that will simplify and standardize platform approaches in Commonwealth executive branch agencies with the following goals in mind.
    - Provide a long-term target architecture vision with opportunities for short-term payoffs.
    - Encourage platform acquisition practices within and across agencies that will result in a more homogeneous platform architecture, improved support, and greater economies of scale.

- Improve citizen/customer services by improving infrastructure and its management in the Commonwealth.
- Influence standards-based requirements in areas such as solutions design, transmission interface selection, mobile computing technologies, where standards are evolving.
- Enable cost-effective central location and/or central management options for platforms.

- Recommend best practices for IT decision making for Commonwealth-wide efforts and for those of the Commonwealth's state and local agencies.
  - Enable the convergence of voice, video, image and data services in the Commonwealth.
  - Encourage well-planned solutions within and across agencies that protect investments and reduce future expenditure escalation.

Platform Architecture Scope

The Platform Domain addresses three technical topics: personal computing devices, servers, and storage. This document will address these topics within the scope indicated below:

- Personal Computing Devices
  - Desktops—Hardware/OS/productivity software
  - Notebooks—Hardware/OS/productivity software
  - Handhelds—Hardware/OS/productivity software
- Servers
  - High-end servers—Mainframes/enterprise servers/OSs
  - Midrange/low-end servers—All other servers/OSs
- Storage
  - Storage model types
    - Network file servers
    - Direct attached storage (DAS)
    - Network attached storage (NAS)
    - Storage area networks (SANs)
  - Storage interfaces and protocols
  - Storage device options
    - Tape subsystems, silos, libraries
    - Disk systems
    - CD and optical systems

Within this document, some important areas will be touched on that are not in scope. When this happens, the area may be in the scope of another technical domain (e.g., routers would be covered in the network domain and database standards in the future database domain). For this domain, recommendations for future scope expansion include personal and networked printers and perhaps, personal computing device disposal.

Definition: Personal Computing Devices

Personal computing devices include a variety of hardware and software components for desktop computers, notebooks, and handhelds. The following definition and discussion provide specific examples of which components and topics may be included and which are excluded from discussions in the platform domain document.

Desktops

Desktops include all non-mobile personal computer hardware, software, and peripherals that might be provided to most Commonwealth employees as networked desktops. Desktops may

be fat or thin clients and may include versions of Macintosh, Windows, and Linux operating systems. Productivity software is considered to be an integral part of the government worker's desktop computer. Productivity software discussed may include office suite, browser, plug-ins, calendaring, scheduling, email client, help desk client, network client, and related software. Hardware includes the CPU, I/O ports, network interfaces, communications buses, memory, storage, power supply, graphics, audio, and controller components. Peripherals discussed here include monitors and media read/write devices. Removable media is also discussed. Other peripherals are considered to be of lesser enterprise importance at this time.

Notebooks

Notebooks include all computing devices that provide desktop functionality to a mobile worker in or out of the office. Pen tablets are included in this category but not specifically covered here. Notebook discussions may cover any of the components in desktops when differences should be noted or mobile computing options that are not relevant to desktops (e.g., specially designed mobile chipsets that conserve battery power).

Handhelds

Handhelds include all computing devices typically used by government workers that provide less functionality than a notebook or specialized functionality. Typical devices include personal digital assistants (PDAs) and cell phone/PDAs. PDA services (e.g., Blackberry email) and limited function devices (e.g., inventory/tracking computers) are not covered. Devices specifically excluded from consideration in this category are voice-only devices including single purpose telephones, cell phones, and communication radios.

Definition: Servers

Servers include both proprietary mainframe computers and computers that function as service-providers in a client-server network. Excluded are hardware devices that function as both client and a server in a peer-to-peer network, bridges, and routers. A server solution may include single servers, virtual servers, clusters, farms, frames of server blades, and n-tier applications solutions. Server configuration capabilities, management options, and shared use options are important considerations in the discussion of servers. Servers include hardware and software as follows: operating systems, remote access software, CPUs, I/O ports/interfaces, communications buses, memory, storage, power, and controller components.

Definition: Storage

Storage refers to the combination of technologies that together enable making a record of business data, which can be indexed and retrieved by servers and clients that need the information. Storage solutions overlap to some extent with the server category. Common combinations of technologies designed to meet storage needs are referred to in this document as storage models. This architecture document focuses on scalable storage models that are external to application servers. Included are file servers, network-attached storage (NAS), storage area networks (SANs), and Direct Attached Storage (DAS). These models all use a variety of media (e.g., tape, disk, and CDs) and interfaces.

Principles

Principles are guiding beliefs. Principles describe the future architecture in global terms. They are intended as guidance for the domain teams. They are less specific than best practices, which are intended to guide agency and central actions and decisions.

General Principles

The following principles apply to all platform topics.

- The Enterprise Architecture should promote platform choices based on technical standards that have been formally adopted by standards groups whenever possible.
- The Enterprise Architecture should promote the design of platforms to meet business needs for availability, reliability, speed, scalability, fault tolerance, and business continuity.
- The Enterprise Architecture should support the use of total cost-of-ownership metrics as one of several important factors in making platform acquisition decisions.
- The Enterprise Architecture should enable solutions that balance platform uniformity goals with platform business efficiency and effectiveness goals.
- The Enterprise Architecture must identify and centralize platform utilities whenever it is practical and cost effective to do so.
- The Enterprise Architecture should enable the comparison of outsourced and in-sourced solutions for platform acquisition and management.
- The Enterprise Architecture should emphasize the importance of considering security as an integral part of platform design and acquisition decisions.
- The Enterprise Architecture should enable the addressing of business continuity needs as part of solutions design.

Principles for Personal Computing Devices

The principles below are specific to personal computing devices.

- The Enterprise Architecture should support the provision of uniform, high-quality productivity tools for employees of the Commonwealth.
- The Enterprise Architecture should ensure that mobile clients use standards-based communications interfaces whenever possible.
- The Enterprise Architecture should enable the integrating of personal computer hardware and software selection strategies to maximize cost savings opportunities.

Principles for Servers

The principles below are applicable to servers.

- The Enterprise Architecture should recognize the importance of permitting server selection flexibility in addressing requirements for many large-scale enterprise business problems.
- The Enterprise Architecture should facilitate taking advantage of consolidation opportunities.
- The Enterprise Architecture should reduce complexity without jeopardizing competition.

Principles for Storage

The principles below are applicable to storage.

- The Enterprise Architecture should provide roadmaps for planning and transitioning in highly volatile and rapidly changing technology areas such as enterprise storage planning.
- The Enterprise Architecture should facilitate viable storage consolidation opportunities.

Platform Domain Technical Topics

In this section, the personal computing, server, and storage technologies are discussed. The discussions cover the current architecture in Commonwealth's executive branch agencies, component technology trends, design considerations, and critical issues. Also, the domain team provides recommended requirements and best practices in each platform area.

The term "component technologies" is used to describe the breakout categories within a domain topic such as servers. The breakouts identify technology categories that are currently undergoing or expected to undergo significant change. Technologies that are relevant to the category are rated using the scheme "Obsolescent, Transitional, Strategic, and Emerging."

Throughout this report, one underlying theme is the transition of the Commonwealth from the distributed information technology islands of today to a more integrated system with greater deployment of shared, centrally managed utility services[6] in the future. The new Virginia's Information Technologies Agency, or VITA, will play a central role in orchestrating this transition. Although much of the cost savings of a central resource is due to decreased management costs, the move to central utilities is also fueled by the improved availability of affordable, scalable, and partitionable platforms.

A second theme of the report is the need to simplify the overall platform architecture (e.g., reduce the number of platform types). A simplified architecture enables the Commonwealth to more effectively leverage enterprise volumes when making purchases and to take advantage of the cost savings related to support simplification, skills transfer, and training.

A third theme is the need to ensure that alternatives are considered. The Commonwealth should always leverage viable alternatives when it negotiates prices for its preferred technology standard. For example, one major de facto standard in Virginia is Microsoft operating systems. In Virginia, this is true for desktops and low-end servers. Regardless of what the main choice is, Virginia needs to study the costs and benefits of switching to an alternative choice to have a sense of reasonable prices for its main choice. This information is very useful in price negotiations and critical for maintaining a big-picture perspective.

Comments and recommendations made within each technical topic are based on assumptions regarding VITA's authority to centralize selected personal computing, server, and storage acquisition and support functions. VITA's purview in matters that control staffing and reinvestments of savings is limited to executive branch agencies excluding higher education. The Enterprise Architecture, however, may also impose requirements on administrative computing activities of higher education agencies.

To create cost effective central platform resources, certain other services must be in place—namely, network connections, privacy guarantees, authentication service, access services, help desks, services management, and service metrics. Because this report focuses on the platform component, these other services will be mentioned throughout this report, but will not be dealt with in depth. Other technical domain teams will take the lead on fleshing out Systems Management, Networking, Middleware, Security and related recommendations.

[6] A utility is a portion of information technology work that may be provided without having significant knowledge of the business. An example would be web site hosting. You can provide server space and accessibility levels without knowing the business of the agency or the content of the website.

However, as the domain team presents its discussions of personal computing, server, and storage platforms, it must make certain assumptions regarding the existence of foundation services that will be provided to support its recommendations. These foundation services are as follows:

- The Commonwealth will establish help desk services for the central utilities.
- The Commonwealth will create regional islands of utility services if cost effective.
- The Commonwealth will create cost-effective connectivity between agencies and central services. Examples include metropolitan area networking (MANs) and other internetworking connections of sufficient bandwidth, availability, security and reliability.
- The Commonwealth will provide access to central services to geographically remote areas if cost effective.
- The Commonwealth will offer privacy and security services to meet application needs in conjunction with the applications and databases that will use central utility services.
- The Commonwealth will mandate specific utility applications such as email services.
- The Commonwealth will provide the staff and systems needed to ensure quantitative and qualitative data requirements are met for central services planning and management.
- The Commonwealth will enable remote management of all desktops.

Advice provided within each technical topic is in the form of either a recommended requirement or an optional best practice. The intent is that the ITIB will consider recommendations of the domain team and concur that the requirements should become part of the ITRM policies or standards.

A variety of stakeholders review domain team requirement and best practice recommendations prior to their being presented to the ITIB. The present process enables broad input to the domain team report through the On-Line Reporting and Commenting Application (ORCA) prior to review by the ITIB. After the ITIB-approved requirements are translated into ITRM technical and governance policies or standards, the resulting documents are also reviewed by the ITIB prior to promulgation. Requirements established through this process are binding on all executive branch agencies except higher education agencies unless specifically noted. Requirements may limit the information technology planning, procurement, deployment, and management activities of VITA or the agencies. Current law exempts higher education from VITA's consolidation efforts, but policies and standards may address issues other than consolidation. Although requirements may be binding on institutions of higher education, the requirements typically do not address technology acquisition or management in the academic and research branches of institutions.

Technical Topic #1: Personal Computing Devices

Personal computing devices include desktop computers, notebooks and handheld computers. The current and recommended architectures for these devices are addressed below.

Virginia's "As Is" Architecture for Personal Computing Devices

Executive branch agencies in the Commonwealth, excluding higher education agencies and independent agencies, report that they use nearly 59,000 personal computing devices[7]. Most of the agencies reported that they used Microsoft operating systems and bundled Microsoft office suite software on nearly all of their desktops and notebooks. A very small number of the 59,000 devices reported for fiscal year 2002 were handheld computers (handhelds include personal digital assistants or PDAs).

In addition to the office suite software that is typically present on most Commonwealth desktops and notebooks, Internet Explorer, Norton/Symantec Antivirus, and Adobe's Acrobat Reader are commonly deployed[8]. Desktops and those notebooks used as a primary computer also usually have network and systems management client software. Notebooks used mainly as mobile devices often have remote LAN access software.

The versions and makers of software and hardware vary dramatically within and across agencies of the Commonwealth. The main companies and products recorded in the fiscal year 2002 portfolio database are presented in Tables 2 and 3 below.

Table 2 shows operating systems presently in use within executive branch agencies separately for higher education agencies (academic and users) and non-higher education executive branch agencies. The data presented show that higher education agencies upgrade hardware and operating systems more rapidly than other executive branch agencies.

When these data were collected, Windows '98 and Windows 2000 (NT) were the latest versions of the two Windows OS tracks for desktops. Windows XP Pro was released in January 2001, just before the data collection was conducted. The then up-to-date, Windows OSs accounted for about 71% of higher education operating systems but only 54% of operating systems in use by other executive branch agencies. Differences between the two agency types in how quickly they upgrade OSs likely reflect differences in business needs.

Considering all Windows versions, the installed base of desktops and notebooks runs about 90 percent Microsoft in higher education and nearly 100 percent Microsoft in other executive branch agencies.

Table 3 presents prevalent software types for non-higher education executive branch agencies.[9] Comparable data are not available to describe the business side of higher education agencies. Table 3 clearly shows that Microsoft products are used on greater percentages of desktops and laptops in nearly every category of software. In fact, the Commonwealth is highly dependent on Microsoft for both operating systems and productivity software.

For productivity software, the tendency for most agencies is to acquire and install bundled office suite software. In FY 2002, about 20 percent of executive branch desktops used separately acquired Word and/or other components rather than bundled software.

[7] Due Diligence database, FY 2002.
[8] Software used is from Portfolio Data reported by agencies during FY 2002.
[9] The FY 2002 data set did not provide consistent software version information.

Table 2: Operating Systems Reported in FY 2002 by Higher Education and Other Executive Branch Agencies

Agency Type	PC OS Versions In Use in FY 2002	Percentage of OSs Reported
Executive Branch Agencies (not Higher Education)	Windows 98	45.3%
	Windows 95	22.7%
	Windows NT	17.7%
	Windows 2000 (NT)	8.2%
	Macintosh OS 9 or earlier	4.9%
	Windows for Workgroups	0.8%
	UNIX	0.3%
	Windows ME	0.1%
	LINUX	0.1%
	DOS	<0.1%
	OS2	<0.1%
	W3.1	<0.1%
Higher Education Agencies	Windows 98	64.0%
	Windows NT	13.8%
	Macintosh	7.2%
	Windows 2000	7.2%
	Windows 95	6.7%
	UNIX	0.5%
	Windows for Workgroups	0.3%
	OS9	0.3%
	LINUX	0.1%
	DOS	<0.1%

Table 3: De Facto Standards for Systems Software in Non-higher Education Executive Branch Agencies

Software Type	Software and Its Relative Prevalence		Included in a Typical System
Office Software for Executive Branch Agencies	Microsoft Office Professional Bundle	Most Prevalent	Yes
	Microsoft Office Bundle	Second	--
	Microsoft Word and Other Unbundled	Third	--
Antivirus	Norton	Most Prevalent	Yes
	McAfee	Second	--
Calendaring/Scheduling/ Mail Client	Microsoft Outlook/ Etc.	Most Prevalent	Yes
Email Service	Microsoft Exchange	Most Prevalent	Yes
	Novell GroupWise	Second	--
On-line Collaboration	Microsoft Net Meeting	Most Prevalent	--

Software Type	Software and Its Relative Prevalence		Included in a Typical System
Document Authoring	Adobe Acrobat	Most Prevalent	--
Web Browser	Internet Explorer	Most Prevalent	Yes
	Netscape	Second	--
Browser Plug-in	Adobe Acrobat Reader	Most Prevalent	Yes
Project Management	Microsoft Project	Most Prevalent	--
Flowcharting	Microsoft Visio	Most Prevalent	--
Desktop Publishing	Adobe (Acrobat; PageMaker; Illustrator; QuarkXpress)	Most Prevalent	--

Virginia agencies generally employ one of two methods for addressing desktop needs. The first method is contracting for seat management services (computers and/or maintenance) for some or all of their desktop and notebook computers. The second method is acquiring and/or maintaining systems using internal staff. Regardless of the methods of acquisition and support, however, replacement of desktops and notebooks by agencies has generally resulted in the following changes.

- Operating systems, software, and hardware upgrades that are compatible with one of the latest Windows operating systems on the market
- Appropriate software upgrades
- Middle priced hardware capable of supporting both the newly acquired software and another upgrade of the software

Although the majority of operating systems in use in FY 2002 were state-of-the-art for that point in time, a wide variety of out-of-date versions were used as well. Even though older operating systems may still have met the user's needs, having multiple versions within an agency may cause support problems, limit agency-wide applications, and raise agency-level support costs.

Note: The Commonwealth has not collected information on PDAs. Also, no separate information is available for platforms that support higher education administrative functions. Higher Education academic functions are not governed by ITRM policies and standards.

Commonwealth's Goals for the Personal Computing Architecture

The Commonwealth's goals in selecting, acquiring, refreshing, deploying, and supporting personal computing devices are as follows.

- Obtaining support cost advantages that will result from including desktops, notebooks and other personal computing devices in a Commonwealth centrally controlled architecture
- Meeting workforce business needs for 3 to 4 years

- Promoting greater consistency in vendors, versions, images, and tool sets to reduce support costs
- Providing office application tools that enable workers to use shared applications and to share documents, mail, and data with most customers regardless of the software product or version used by the customer
- Providing effective within-agency workgroup tools (e.g., scheduling)
- Having solutions that have sufficient penetration in the marketplace to ensure support staff availability
- Using a standardized methodology to minimize costs and maximize benefits when selecting from among alternative technologies and support options (e.g., outsourcing vs. in-sourcing selected services or choosing from available technology options)
- Setting life cycle length to maximize useful life while controlling escalation of support and other costs

Issues/Challenges

Some problems and concerns related to selecting, deploying, and managing personal computing devices in the Commonwealth are as follows:

- Concern about having an affordable personal computing solution (e.g., being able to continue with de facto Microsoft standards for OS and productivity software if Microsoft uses its virtual monopoly to force unacceptable price increases and licensing changes)
- Concern about costs associated with transitioning from a de facto standard to a new architecture (e.g., high costs of retraining the workforce, developers, and support staff if the Commonwealth were to change from Microsoft to a different OS and/or personal productivity suite)
- Concern about whether marketed personal computing platforms are built for actual business needs (e.g., some features may be more appropriate for gaming than for office systems)
- Concern about the cost-effectiveness of acquiring desktop computers with monitors (e.g., monitor's replacement life cycle is two to three times as long as that of the computer, but the monitor is usually replaced when the computer is replaced)
- Concern about not taking advantage of savings that may accrue from including desktops, notebooks and other personal computing devices in the Commonwealth's centrally controlled architecture
- Concern that how long an agency keeps computers is a decision based more on funds availability than on overall costs or customer business needs (e.g., the economy has also had an impact on the business community's view of desktop and notebook life cycles, which have been changed from 3 to 4 years in many businesses)
- Inability to maintain consistency in the computing environment due to constant marketplace changes that are often unrelated to business needs (e.g., changes in

software versions and OS versions that sometimes have little business enhancement value)

- Concern about unplanned support cost escalation for PDAs (e.g., due to lack of controls on customer acquisitions and due to having to support multiple PDA types)
- Concern about choosing a PDA standard and planning for PDA support when PDA features and functions are constantly changing (e.g., PDA vendors are making continuous advances in function; changes in hardware are frequent; and new players are entering the PDA marketplace)

Technology Component Trends

Table 4, below, presents personal computing technologies as of mid 2003 and rates them as obsolescent, transitional, strategic, or emerging. Only those personal computing technology components that are undergoing significant change (i.e., have an entry in at least one category in addition to strategic) are included in this table. The selections reflect technology advancements in mid 2003. Use of these technologies may improve the cost effectiveness or business utility of Virginia's computing architecture. The strategic column indicates the recommended technologies for Virginia's executive branch agencies.

In the world of personal computing, the target device architecture will change frequently. In the opinion of the domain team, VITA should ensure once to twice-yearly reflections on personal computing architecture recommendations.

Table 4: Technology Use Trends for Personal Computing Devices[10]

Obsolescent	Transitional	Strategic	Emerging
OS Desktop/ Notebook Windows '95 Windows Me (not an enterprise OS) Windows 3.11 Windows XP (home)	**OS Desktop/ Notebook** Windows '98 Windows NT Workstation 4.0 Windows 2000 Macintosh OS 9	**OS Desktop/ Notebook** Windows XP Pro	**OS Desktop/ Notebook** Linux (kernel 2.4.20 on 1-20-03)[11] (test) Longhorn Windows (2004-5) Macintosh OS X

[10] Requirements in this table apply to executive branch agencies, including the administrative units of higher education.
[11] See www.kernel.org for latest kernel.

Obsolescent	Transitional	Strategic	Emerging
		Display Flat Panel Cathode Ray Tube; LCD; TFT[12] LCD - compatible with analog RGB interfaces	**Display** Mira[13] detachable monitor/pen tablet (Prototype) Flat Panels that use new digital interface DVI-I[14] (digital visual interface standard) and TMDS (transition minimized digital signaling)
Personal Computing Chipsets and Supported Interfaces Pentium II and earlier	**Personal Computing Chipsets and Supported Interfaces** Pentium III; Celeron; Power Mac G3; Power Mac G4 Old serial PS/2 parallel IDE is ATA 66, ATA 33	**Personal Computing Chipsets and Supported Interfaces** Pentium 4[15]; Athlon XP; Mobile Pentium III; Mobile Pentium 4 M[16] Intel Centrino[17] (chipset plus) USB 1.x; USB 2.0[18]; SCSI, FireWire or IEEE 1394 (serial); PCMCIA IDE is ATA 100; Serial ATA[19] 1.0 is primarily for internal PC storage PCI 2.2, PCI X 1.0	**Personal Computing Chipsets and Supported Interfaces** Hyper-Threading[20] (test) PCI Express[21], PCI-X 2.0 and PCI 2.3 [22]

[12] Thin Film Transistor
[13] Viewsonic Mira is based on Windows CE.Net and uses the 802.11b wireless LAN protocol to maintain a connection between the monitor and the computer.
[14] A good but technical article on DVI. http://www.ddwg.org/data/press/2001_04_26_edn.pdf
[15] Pentium IV chipsets Intel 845GV, 845E, 845, and E7500, E7501 are current (see http://www.intel.com/design/chipsets/embedded/ for details
[16] For more information on power management and videoconferencing enhancements of the mobile chipset see http://www.intel.com/products/notebook/processors/pentium4-m/index.htm?iid=sr+4
[17] Centrino is Intel's Pentium M processor (formerly codenamed Banias), the 855 chipset and the PRO/Wireless 2100 Network Connection (currently an 802.11b solution), The chipset permits longer battery life in notebooks and in systems with wireless radios. The combination permits Centrino branding—although the connection solution will change.
[18] USB 2.0 is fully backwards compatible with USB 1.0 devices.
[19] Serial ATA 1.0 and II working groups http://www.serialata.org/
[20] Hyper-threading is a feature of the Pentium 4 3.06 GHz chip. It enables one processor to appear as two. It should make Windows 2000 and Windows XP run better because they are designed to be multitasking. It is only for desktops and may cause some performance degradations. For this reason, it must be tested in an environment before enabling the hyper-threading capability.
[21] PCI Express may have no effect in the desktop arena. This may catch on in the server environment.
[22] For more information on PCI see http://www.pcisig.com/home

Obsolescent	Transitional	Strategic	Emerging
Peripherals[23] Zip Drive (Iomega) 5 ¼ Floppy	**Peripherals** CD ROM Jaz Drive (Iomega successor to Zip Drive) Floppy Drive (3.5")	**Peripherals** CD RW/ DVD ROM Combo Drive DVD ROM CD RW	**Peripherals** DVD (no standards agreed upon for DVD authoring) DVD-R DVD-RW DVD+R DVD+RW
	Mobile Components Modems (V.34 and earlier)	**Mobile Components** Modems (V.90) IrDA—infrared PC Cards (PCMCIA) 802.11a cards (54 Mbps, OFDM, 5.5 GHz) 802.11b cards (2.4 GHz FHSS or DSSS) Bandwidth Combination Cards for 802.11 (a+b) e.g., Atheros	**Mobile Components** Modems (V.92[24]) Power management (DFM -Dynamic Frequency Management) SIM cards for client transmitters (subscriber identification module) for seamless roaming between different types of networks Bluetooth devices, 1Mbps, FHSS, 2.4 GHz)[25] 802.11g cards (54 Mbps OFDM, 2.4 GHz-standard ratified in July, 2003) Bandwidth Combination Cards for 802.11 (a+g, a+b+g) e.g., Atheros

[23] Peripherals does not include printers (either personal or networked), scanners, printer/copiers, or similar devices at this time. These devices will be addressed at a later date if cost savings seem likely.
[24] V.92 supports quick connect, modem on hold, and 48K upstream transmission.
[25] Bluetooth is presently too expensive compared to IrDA and other methods for connection. For a good discussion of Bluetooth technologies see http://www6.tomshardware.com/network/20020626/bluetooth-09.html . This article recommends TDK implementations of Bluetooth.

Obsolescent	Transitional	Strategic	Emerging
Productivity/ Management Software Microsoft Office '95; Outlook	**Productivity/ Management Software** Microsoft Office 2001; Outlook Express 5 (Mac) Microsoft Office '97; Outlook WinZip (compression now in Windows XP)	**Productivity/ Management Software** Microsoft Office XP; Outlook Microsoft Office 2000; Outlook Internet Explorer (highest) Adobe Acrobat Reader (and plug in)	**Productivity/ Management Software** Microsoft Office 2003 (evaluate) Corel WordPerfect Office 11; Corel Central StarOffice 6.0 Open Office Microsoft Office V.x; Entourage (Mac) Netscape (highest) Open Source Browsers (e.g., Mozilla) Centrally managed services clients; centrally selected Antivirus
	OS PDA, Pen, etc.[26] Palm OS (current and older versions do not support enterprise needs)	**OS PDA, Pen, etc.** Blackberry OS (RIM)	**OS PDA, Pen, etc.** Palm OS (future revisions may have business oriented features) Symbian OS 6.0 (Smart Phones) Symbian OS 7.0 (Beta) EPOC = Symbian Windows CE (Handheld PC) Windows CE .Net (Beta)
	Related Hardware/ Media Floppy disks 3.5"	**Related Hardware/ Media** Key Storage (uses USB port as writer/reader)	

Table 4 provides conclusions drawn by the domain architecture team that reflect personal computing technical component recommendations in mid 2003. However, the team feels the Commonwealth needs to have a defined review process in place. The review process should reestablish a domain team of 8 to 12 persons, study new personal computing issues and costs, and recommend a revised component trend table.[27]

Personal Computing—Recommended Requirement 1: *Enterprise Architecture Staff shall convene a personal computing platform domain team meeting twice*

[26] The architecture does not address pen tablets or cell/PDA devices at this time.
[27] Enterprise Service Directors (ESDs) who have a broad knowledge of agency business requirements are examples of individuals who would make good team participants. Teams may also employ surveys and focus groups to assess changes in business needs.

annually to review personal computing technical trend recommendations and provide revisions as needed.

The team shall review the target architecture recommendations for personal computing and study critical issues in-depth. The team shall be comprised of individuals knowledgeable in personal computing areas including: business needs, technologies, procurement, price negotiations, deployment, maintenance and support.

Personal Computing Technologies—Generally

Personal computers are the platform acquired in the greatest quantity by the Commonwealth. For executive branch agencies, the total cost of ownership for personal computing exceeds $0.5 billion (over 3 years). With increased central control of personal computing solutions, savings opportunities could be as high as 20 to 30 percent or $37 to $46 million per year. Total savings for the Commonwealth may be greater if cost savings strategies have significance for local governments, K-12 schools, academic users in higher education, and other branches of government. The savings may be small from the viewpoint of government-wide operations, but from a technology reinvestment viewpoint savings of this magnitude could provide significant opportunities for change.

Without central control, savings from personal computing hardware, software and support may not be realized. However, certain up-front costs are affiliated with central control. These up-front costs may be financed though reinvestment of savings and from service fees. This sentiment is echoed by 2003 Appropriation Act language that permits the Virginia Information Technologies Agency (VITA) to recoup costs from "desktop support, help desk operations, and desktop … licenses." The Appropriation Act also requires that central staff and agencies conduct total cost of ownership studies to support decisions. However, in addition to having good information on the present environment and total costs, it is also important that VITA consider the costs and benefits of competing alternative solutions. The domain team provides several recommendations regarding central control, the need for good information, costs, and benefits.

Personal Computing—Recommended Requirement 2: *To strengthen policy input for VITA decision makers, VITA staff shall devise and track metrics on personal computing devices for executive branch agencies.*

Metrics may include costs, customer satisfaction, and environment mix within and across agencies. VITA staff should use sampling methods, procurement systems, help desk statistics, expenditure data, and aggregate statistics where possible to reduce metric estimation costs.

Personal Computing—Recommended Requirement 3: *VITA staff shall examine cost and benefit data for personal computing in the aggregate (i.e., across agencies). A decision that provides the best savings across agencies may not always provide the best savings in every agency. VITA staff must have the flexibility to implement the simpler solution that significantly benefits most agencies and users.*

Personal Computing—Recommended Requirement 4: *VITA shall centralize personal computing decisions regarding what may be procured, how frequently*

devices may be refreshed, how agency support is to be provided, what security methods are acceptable, and what methods of email access (e.g., wireless push email systems for PDAs) may be used.

Personal Computing—Recommended Requirement 5: *As certain decisions regarding personal computing platforms move from agencies to VITA, VITA shall ensure an annual or more frequent process for assessing the changes in personal computing business needs within and across agencies.*

Personal Computing—Recommended Requirement 6: *VITA shall provide location-based personal computing support options for geographically dispersed agency groups when central services are inadequate to meet customer needs. Costs and benefits of location-based services must be separately evaluated.*

Displays

For computer displays, there are two opportunities for small savings. One is related to the type of monitor acquired and the other to the life of the monitor. The present tendency in state agencies is to replace desktop monitors at the end of the PCs lifecycle. GartnerGroup and others suggest that the lifecycle of a desktop CRT is six to ten years while the lifecycle for a PC is generally three to four years. The Commonwealth could realize a small savings by delaying the replacement of monitors that continue to meet business needs and user performance requirements. A "use until display performance has declined[28]" policy would decrease immediate acquisition, delivery, setup, and disposal costs without affecting the user except in the rare instance that the monitor actually dies before its designated replacement time. Decisions about replacement timing should consider support cost differences and savings attributable to acquisition delay, which permits further decline in the cost of flat panels.

Some factors influencing the user's desire to obtain a monitor with a replacement system are the availability of affordable flat panels[29], a desire to have the entire system match in case color (beige is being phased out), and the small difference in total system price typically allowed for excluding the monitor from the purchase. The flat panel is of particular interest to users because it is aesthetically pleasing and has less flicker than a CRT. The flat panel also uses slightly less electricity, generates slightly less heat, may last longer, and may improve useable space in an office. However, the flat panel monitor is not a better monitor for all business uses and no reliable information is available regarding how well it may fare in the workplace.

The average flat panel has several drawbacks. It presently costs about two to three times as much as the average CRT[30]; does not handle motion video well, is less flexible in providing resolution options; and has poorer color adjustment capabilities. Although manufacturers

[28] CRTs typically do not die. What happens is that the brightness of the display decreases over a period of years, the number of which depends on how many hours per day it is in use. A monitor is considered to be at end of life when the display brightness decreases by 50 percent.

[29] The 15 inch flat panel presently on contract with Dell is possibly of lower quality than may be optimal for the aging workforce.

[30] Virginia's contract with Dell, for example, shows the majority of CRTs at about $150 and flat panels around $450. The range in price is about $100 to $360 for a CRT and $327 to $1,356 for a flat panel.

argue that a 15-inch flat panel is equivalent to a 17-inch CRT, most users will want a 17-inch flat panel, thus increasing the cost differential. However, in cost comparisons, the 15-inch flat panel will fare well against the CRT sooner and become the better buy in the near future as prices continue to drop. The flat panel will definitely be the better buy as a user's next monitor if the user's current monitor is used until performance drops. CRTs will likely begin to increase in price as the market share continues to switch to flat panels.

Because most users would choose a flat panel regardless of its shortcomings or costs, controlling the changeover centrally will ensure a more cost-effective transition. Except when business needs dictate a different solution, the Commonwealth should slow the switch to flat panels until they are cost effective and until CRTs finish their useful life.[31]

> ***Personal Computing—Recommended Requirement 7:*** *Because desktop displays have a longer lifecycle than the computers they support, their replacement shall not be automatic at the time of a desktop replacement. Display replacement decisions for all agencies including administrative units of higher education must be based on customer business needs, support considerations, cost-of-ownership data, and hardware compatibility considerations. VITA shall provide separate display acquisition pricing. Also, VITA shall provide cost-benefit data and display selection criteria for CRTs and flat panel monitors.*

Chipsets

For personal computers, the Intel chipsets dominate, but Athlon and others offer equivalent or better quality and features. At present, available Intel chipsets include features that exceed the needs of the typical office worker. Most likely, a middle- to lower-end chipset is adequate to meet workforce needs. Examples of high-end features that are best reserved for high-end users or servers include support for FireWire interfaces, hyper-threading, and PCI Express.

Speed and performance requirements for the average business user tend to be driven by changes in operating system and productivity software requirements. Also, for notebooks, special chipsets are now available that address mobile computing needs.

> ***Personal Computing--Optional Best Practice 1:*** *When establishing minimum specifications for bids for low-end personal computers, VITA should use the lowest of currently available Intel, Athlon, or comparable chipsets that will meet anticipated processing needs for the proposed productivity software for the proposed refresh cycle.*

> ***Personal Computing—Optional Best Practice 2:*** *VITA should select specialized chipsets for notebooks to better meet the needs of the mobile worker.*

Peripherals

This paper does not address all peripheral devices. The main peripherals addressed here are desktops and notebook devices that read from and write to external media. Printers and

[31] The environmental costs of manufacturing the CRT are higher than those of the flat panel. This is a better argument for keeping the already manufactured CRT for their full life than for replacing 3 and 4 year old CRTs with flat panels.

scanners are beyond the established scope of this document, although domain team members recommend that additional peripherals including printers be considered in the near future.

"Writable" media for desktops and laptops is changing from floppies to CD at present and will change to DVDs in the future. Currently, DVD write standards have not solidified. A plethora[32] of other media is available for transferring data and images to and from the desktop and laptop computers including USB keys.

> ***Personal Computing—Recommended Requirement 8:*** *When establishing minimum bid specifications for personal computers, VITA shall include CD writers as standard output devices. Floppy drives and DVD readers should be optional. The acquisition of DVD writers shall be discouraged until a single standard is ratified. This requirement applies to agencies including the administrative units of higher education.*

Wireless Connectivity Devices

Although use of wireless technologies for mouse and keyboard connections is becoming more popular, the typical wireless connections in Commonwealth offices are for notebook connections to the network and PDA connections to desktops.

Several technologies support mobile device interfaces with networks including modems, infrared devices (IrDA), Bluetooth, and wireless network interface cards (IEEE 802.11 or WiFi). Bluetooth personal area network interface technologies (radio frequency, 10 meter) are expected to eventually replace infrared (optical, half meter) connections because of the relative improvements in speed, distance and flexibility, but infrared is presently the main affordable alternative to cabled connections.

IEEE 802.11a, b and g products are now available in one card both singly and in combinations (e.g., one card provides both a and g frequencies and transmission methods) for providing wireless connectivity. Network Interface Cards (NICs) based on 802.11a and g protocols offer the better transfer rates for wireless LAN connectivity.

Because of the increase in wireless services, especially in public places including hotel, conference rooms, etc., the mobile worker now can benefit from wireless connectivity even if the office LAN is not wireless. With this type of change taking place, agencies should introduce use policies for wireless connectivity that are appropriate for their business. For example, the agency may want the user to send emails using encryption on wired connections but may encourage the free use of public Internet access.

> ***Personal Computing--Optional Best Practice 3:*** *VITA should equip the standard mobile notebook computer with a wireless (e.g., IEEE 802.11 standard) interface card to enable state workers to take advantage of wireless connectivity provided in public spaces. Alternatives may be required if many agencies are concerned about allowing employee discretion in using wireless services.*

[32] Notebooks have several interfaces that are being used for a variety of connectivity, storage, and other purposes. A variety of device types including CompactFlash, Flash Memory, Memory Stick, MultiMediaCard, Secure Digital, and SmartMedia device types support PC Card (PCMCIA Types I, II and III), USB (1.0 and 2.0), and FireWire (IEEE 1394, serial) interfaces. Other common devices include modems, network interface cards, wireless network cards, and ATA serial storage. A given device may support one or more interface type.

Microsoft or Open Systems—OS and Productivity Software Decisions

Virginia is not alone in having a de facto Microsoft standard for personal computer operating systems and productivity software. Governments and businesses are predominantly Microsoft worldwide. However, recent changes in Microsoft approaches to business partnerships, software licensing, hardware drivers, home use licensing, version-to-version compatibility, and upgrades are influencing governments and businesses worldwide[33] to reconsider whether Microsoft is the only viable option[34].

Many articles have been written that detail both the concerns customers are having about how Microsoft does business and the rise in efforts to examine alternatives to using Microsoft products[35]. If Microsoft products become viewed as too costly, and if their competition control strategies become too effective, Virginia will have to consider alternatives.

Some of the questions that Virginia needs to address regarding Microsoft are: how much is too much to pay for Microsoft systems; how does using Microsoft limit Virginia's other choices; and what viable alternatives does the Commonwealth have. The answers can be found only in a study of alternatives and their costs and benefits. The Commonwealth can use studies to make a case for continuing with all or some of the Microsoft products used by agencies, switching to alternatives in one or more instances, or leverage options in negotiating prices with Microsoft and others. Simply accepting the de facto standards for software and operating systems however, will not benefit Virginia as fully as exploring effective and efficient alternatives.

One frequently cited argument for not switching from de facto Microsoft standards is the training costs affiliated with making a change (i.e., user, programmer, and technical support staff training). When assessing training needs for making a switch, Virginia should consider both the training needs that exist with no change in products and the office suite functionality needed across agencies, positions, and business uses. Virginia should also consider what training really works well to improve a knowledge workers' ability to use the tools they have to do their work. The retraining of application developers is also an important issue.

---

[33] Is Microsoft losing ground to Linux?, CNET News.com, November 4, 2002 http://www.globetechnology.com/servlet/ArticleNews/tech/RTGAM/20021104/gtopenms/Technology/techBN; Is Microsoft losing its grip?, Clive Akass, August 29, 2002, http://www.pcw.co.uk/news/1134288; Aussies dump Microsoft for Linux, Nick Farrell, August 20, 2002, http://www.vnunet.com/News/1134470; Internetnews.com, Free OpenOffice.org 1.0 Suite Available, Eric Grevstad, May 1, 2002, http://www.internetnews.com/dev-news/article.php/10_1026221; USA Today, AP, Provincial German town drops Microsoft for Linux, March 24, 2003, http://www.usatoday.com/tech/news/2003-03-24-linuxburg_x.htm; Kuro5hin, Backlash against Microsoft intensifies in Taiwan; MS investigated for price gouging (MLP), Andy Tai, May 8, 2002, http://www.kuro5hin.org/story/2002/5/7/224731/9336.

[34] GartnerGroup, The Changing Office Productivity Application Market, 26 March 2002, Michael Silver and Simon Hayward: " Today, Microsoft dominates the office productivity application space with the Office suite. Enterprises have acquiesced until now, but we are increasingly hearing that they would like to have a choice. Much of this is driven by the changes Microsoft announced to its licensing policies in May 2001, which finish going into effect on 31 July 2002. These changes require enterprises to pay Microsoft an annual fee for software maintenance, or re-buy the entire license instead of buying upgrades when they desire, at approximately double the cost."

[35] GartnerGroup, The Changing Office Productivity Application Market, 26 March 2002, Michael Silver and Simon Hayward

Many users of suite software do not know all the features that are available to assist them in their work. These same users may not be able to obtain skills needed from traditional office suite training courses. An assessment of functionality needs and employee skills in using the software functionality would be an important part of assessing retraining costs. Assessing how users presently access functionality and how they might best translate their style to the new software would also be important. This could be done on a sample of staff rather than for the whole workforce. Retraining costs for knowledge workers would be the difference between training to bring workers up to speed on functions using the latest revision of Microsoft Suite software (e.g., XP) versus training needed to bringing them up to speed on an alternative such as OpenOffice or Sun's StarOffice. The effectiveness of training solutions proposed could be tested on a sample of workers as well.

Another very important factor in exploring relative costs is developing an awareness of which agencies and to what extent agencies use current suite tools in providing interfaces to or outputs from business systems. These agencies and their workers would be affected to a much greater extent by any changes in suite tools, and these costs should be considered when alternatives are examined.

Because the desktop suite decision cannot be completely separated from the network and the business applications that support the desktop user, a cost analysis comparing suite alternatives should also compare any options under consideration for operating systems, email, workgroup software, business systems interfaces, or help desk tools. Here, the effect of version-to-version changes should be compared with the effect of brand-to-brand changes.

The strategic time for Virginia to investigate alternatives to Microsoft is now, at the beginning of VITA's central cost control and consolidation efforts. Also, Microsoft's control over customers and third party companies escalates with Office 2003, which became available in late 2003. Office 2003 is not backwards compatible with Microsoft's own Windows '98 and earlier operating systems. However, new versions of other company's office suites will run on earlier Windows versions back to at least Windows '98.

Microsoft has good products, but good alternatives do exist. For Windows, Macintosh's OS X and Sun's Solaris are good UNIX-based operating system alternatives. Linux is also becoming a desktop OS alternative. Office software such as Sun's StarOffice, Corel's Office Suite, and browsers including Netscape are strong products even though their market share is small. Linux OS, OpenOffice productivity software, and the Mozilla browser are examples of free, open source products that are being used by some who have switched from Microsoft.

According to GartnerGroup and others, changing from one office productivity suite to another will result in costs related to training for the workforce and support staff and opportunity costs related to time lost during the learning curve that outweigh any likely savings that might be gained from making a switch. Still others indicate a total cost of ownership for open systems that is 25 to 50 percent less than that of Microsoft—plenty of room to absorb one time retraining and refitting costs. When calculating costs, the Commonwealth should look beyond the point of change and include differences in costs incurred over time due to relative frequency of product changes (e.g., patches and upgrades) across companies.

There are quite a few examples of countries and governments making the switch from Microsoft. While these efforts may provide additional data that either counter or provide

credence to GartnerGroup's claims, Virginia should conduct its own study using costs appropriate for a large state government to ensure valid data for decision makers. Virginia's study should use Virginia's salaries, Virginia's software license negotiation results, Virginia's retraining requirements based on its staff competencies, Virginia's hardware refresh rates, etc.

In the past year, Virginia's procurement officials have joined with other state governments or other universities nationwide to negotiate Microsoft prices as a group. Although some doubt the ability of consortiums to have a significant impact by combining forces, the occurrence of backlash activities (e.g., conversion to open systems and other alternatives) worldwide may serve to increase the effectiveness of these groups. Backlash activities include governments in other countries, some local governments in the United States, portions of the U. S. military, and others using Linux OS and Open Office. Virginia should not follow suit without investigating the affect it would have on costs as identified by GartnerGroup and others.

Personal Computing--Optional Best Practice 4: *The Enterprise Architecture team recommends that Virginia conduct its own controlled study of the costs and benefits of desktop provision alternatives and other personal computing alternatives as soon as possible. Options for support, hardware, and software (e.g., OS, productivity software, antivirus software and management software) would be addressed. The proposed study for desktops would provide information on alternatives to the presently used Microsoft desktop solutions, which could be used to establish reasonable cost targets for future Microsoft product negotiations. If unsuccessful in Microsoft price negotiations, Virginia would then have a viable alternative strategy to implement that would cost less and meet business needs. When comparing personal computing alternatives, Virginia should:*

- *Establish lifecycles for desktop and notebook hardware that are appropriate for the specific solution. For example, Microsoft products may require a 3-year refresh due to escalating resource usage by Office suite upgrades and an open systems solution might have a lifecycle of 5 years.*
- *Compare the following solutions at a minimum: 1.) A Microsoft OS with Microsoft Office Professional 2003; 2.) A Microsoft OS with an alternative office suite (perhaps StarOffice, Corel, and OpenOffice); and 3.) An open systems solution such as Linux with OpenOffice or Sun's Java Desktop.*
- *Compare workforce training/retraining cost using training to the functional requirements of typical jobs for each alternative suite.*
- *Separately calculate one-time changeover costs including application modifications.*
- *Compare support staffing and support staff training requirements (including development staff training).*
- *Use an appropriate mix of current hardware and software as the baseline from which change costs are to be calculated.*
- *Obtain and use appropriate information on support/programming skills of the current Commonwealth technical workforce.*

Target OS and Productivity Software

OS and productivity software should be standardized across executive branch computers for a variety of reasons including opportunities for reduced licensing costs and lower support costs. Having standardized clients on standardized networks also helps those providing systems management to select an effective solution.

Commonwealth agencies presently employ several Microsoft products. Microsoft operating systems are deployed in sufficient percentages for Microsoft to be the de facto standard. Until data are available from Commonwealth studies to support a change from the present direction, the Enterprise Architecture should reflect this de facto trend and should also encourage more complete standardization on any de facto office productivity software acquired in large quantities.

Until information recommending a software solution is obtained from studies of alternatives, the Commonwealth should select software from Table 3 above to be included in the target architecture for desktops and when appropriate, notebooks. The selections should be part of the proposed base image for all standard computers. Future base images should include study recommended software for meeting OS, productivity, and antivirus software needs, and client software for any centrally controlled networking, systems management, or help desk solutions. The following recommendations address information needs and the target software architecture selections prior to conducting a study of alternatives.

Personal Computing—Recommended Requirement 9: *VITA shall determine the productivity software needs in the Commonwealth (e.g., percentage of the workforce that requires various combinations of the individual office software offerings including word processing, presentation, spreadsheet, and database software) for considering the most cost-effective desktop, laptop, PDA, and base image alternatives.*

Needs information can be used in estimating the costs of personal computing alternatives and the costs of modifying the desktop base image for those groups needing additional personal or agency functionality.

Personal Computing—Recommended Requirement 10: *Enterprise Architecture Staff shall periodically convene a team to determine the best antivirus software for inclusion in a desktop base image given: relative protection levels provided, how updates are accomplished, maintenance costs, impact on the network, company history, company plans, and software/license costs. The decision must be coordinated with the network antivirus engine selection decision. The team shall involve members of the Platform, Network, and Security Domain Teams. Agencies should use a highly rated antivirus software (e.g., by Norton (Symantec), McAfee, Panda, PC-cillin, or Eset) until the Enterprise Architecture recommendations are released.*

Personal Computing—Recommended Requirement 11*: The Commonwealth's target personal computing software architecture for new desktops and notebooks for all agencies including administrative units of higher education shall include: Microsoft Office Professional (2000 or XP), Internet Explorer, and Adobe Acrobat Reader. This software is to be provided in the standard desktop image for*

the Commonwealth executive branch workforce excluding administrative units in higher education. This standard shall remain in effect if cost effectiveness is confirmed by a Virginia study of alternatives and price negotiation results.

Mobile workers often require local area network (LAN) connectivity via remote access software. It may be advantageous to standardize remote access software, hardware, and methods based on the major "connect to" requirements.

To maximize the standardizing of base images and modules for desktops and notebooks, the Commonwealth will have to arrive at standards for the entire computing environment including areas that are beyond the scope of the platform domain. Important areas for consideration include email, security, remote management, help desk, network operating system (NOS), databases, and internetworking. These decisions are beyond the scope of the platform domain.

***Personal Computing—Recommended Requirement 12**: VITA shall develop starting point, typical base images for the most commonly needed desktop and notebook computer types to reduce setup decision making and costs. This should include appropriate software setup and system lockdown policies.*

Desktop and Notebook OSs

Table 4 indicates that for desktops and notebooks, the domain team selected only one operating system for the target architecture. This decision was based on the prevalence of Windows OSs in the state, the improvements in Windows XP Pro OS, and the potential for decreasing support costs by decreasing the number of OSs in use. If acceptable licensing costs cannot be reached in negotiations with Microsoft, other OSs including Linux and Macintosh OS X should be considered. A thorough cost study would be needed to support a change to an alternate OS from the de facto standard in the Commonwealth.

***Personal Computing—Recommended Requirement 13**: The Enterprise Architecture establishes Microsoft Windows XP Pro as the present target operating system for Commonwealth desktops and notebooks. This standard shall apply to all agencies including the administrative units of higher education and shall remain in effect if cost effectiveness is confirmed by a Virginia study of alternatives and price negotiation results. (Note that the support lifecycle for Windows XP Professional is as follows: product availability—December 31, 2001; mainstream support—December 31, 2001 through December 31, 2006; extended support—December 31, 2006 - December 31, 2008. Computers acquired in January 2005 would be beyond extended support at the end of a 4-year lifecycle. An alternative strategy would be needed by this time.)*

Related Hardware and Media

Whenever external storage media shift to newer technologies, agencies need to plan for conversion of any saved information to the newer device. Currently, floppy disks are being replaced in the marketplace by other storage media including CDs, memory sticks, USB keys, and DVDs.

Personal Computing—Optional Best Practice 5: *VITA should notify agency heads that floppy disk drives are no longer standard equipment on new computers. Agencies should implement plans that mitigate the effects of this change.*

When interfaces move to obsolescence, expensive converters may bridge the gap between old devices and new interfaces. ISA slots and parallel ports are slowly disappearing from computers. A variety of new storage media types are hitting the market. Personal computer interfaces are being used to provide storage solutions and data porting solutions using USB keys, MemorySticks, and other device types. Such devices may allow agencies to have laptops without CD-ROM or floppy drives. A small number of drives could be shared among many users when needed.

Key fobs and smartcards are used increasingly in state government for adding an authentication security layer for accessing networked servers and personal computers. Smartcards and biometric authentication devices typically require a reader that attaches to the personal computing platform in the form of a keyboard/reader combination or a separate reader. Key fobs are usually key ring or medallion objects and smartcards are in credit card form. Some Key fobs provide pin accessible password tokens that are keyed into the system or application, some signal to an RF reader that may be attached to an RS232 interface on the PC or server, and others are inserted into a USB port and read by software.

Because Fob readers tend to be costly unless included in a keyboard, the USB port option has cost advantages as long as accessing the port does not require crawling under a desk with a flashlight. Newer computers tend to include USB ports on the front and on the back of the tower. This makes use of a USB port device far more practical.

Platforms Generally—Optional Best Practice 1: *VITA should require that desktop and server units on state contract have multiple front facing USB ports. This is an enabler for using USB key fobs for authentication, USB keys for storage, PDAs, and other USB peripherals.*

PDAs

Personal Digital Assistants or PDAs offer a variety of valuable business functions (see Table 5), but little is known about what functions the workforce needs or the extent to which PDAs are currently used in the Commonwealth. Even though the PDA itself is a relatively low cost item, the costs for support can be staggering. For support considerations, the Commonwealth must have a PDA policy and should limit the number of device types it permits. Support staffs should not be expected to accommodate every PDA on the market or PDAs that are not designed for enterprise use.

Support cost estimates for PDAs made in 2002 range from $100 to $3,700 per year[36], with the simple low-end, desktop-synchronized, personal information devices being the least costly and the server-synchronized devices with wireless push email being the highest. Because of the high cost of PDA devices with multiple wireless services, the Commonwealth should provide guidelines for the type of user for whom the devices are cost-beneficial. For example, an agency may wish to restrict the high-end devices to those executives who spend

[36] Wireless PDA Costs $3000 per year, June 24, 2002, 3G, http://www.3g.co.uk/PR/June2002/3597.htm; PDA TCO Sticker Shock, Jack Gold, September 5, 2002, ZDNet Tech Update, http://www.3g.co.uk/PR/June2002/3597.htm.

most days away from the office and who can eliminate the need for a notebook by using the device. Other types of users who could benefit greatly from high-end devices are technical support persons, itinerant support staff, critical systems and services managers, and security staff. The low-end devices are appropriate for many more users. Employees who have multiple meetings each day can use the devices for reaching contacts, scheduling the next meeting, reading and responding to email during breaks, and for taking notes during meetings (e.g., perhaps with a keyboard attachment). With wireless cards, these users can also use free Internet services provided in hotel lobbies and other public spaces.

It is also important from a cost of ownership perspective that the agencies not provide the same services to employees in multiple ways. Agencies should not give one employee a wireless notebook, a wireless PDA, a pager, and a cell phone with Internet services. Agencies should focus on the functions and the most cost-effective way to provide them.

Many multifunctional PDAs are now competing in the marketplace. Some have better features than others for providing services to the networked workforce. Also, some are more easily supported than others. Table 5 provides examples of the PDA functions that may be useful to the executive branch workforce.

Table 5: PDA Functions for Four Typical PDA Types

	Simple PDA	Simple PDA with Wireless Connectivity	PDA plus Wireless Email	PDA plus Wireless Email and Phone
Personal Information Management (Calendar, Contacts, Tasks to Do)	X	X	X	X
Word processing	X	X	X	X
Spreadsheet	X	X	X	X
Synchronization	X	X	X	X
Shelf/Custom Applications	X	X	X	X
Internet Connectivity		X	X	X
Wireless services (wide variety available)			X	X
Authentication			X	X
Secure Transmission			X	X
Email Connection			X	X
Email Attachment Opening Applications			X	X
Email Alerts			X	X
Email Push Service			X	X

	Simple PDA	Simple PDA with Wireless Connectivity	PDA plus Wireless Email	PDA plus Wireless Email and Phone
Reference Data			X	X
Paging			X	X
Business Information Access (HR, Legislation)			X	X
Management Tools for Support			X	X
Voice Communications				X

More information is required on the PDA needs of the Commonwealth workforce. Enterprise Architecture should evaluate workforce needs, PDA capabilities, and ownership costs periodically. The evaluation group should include members of the network domain, procurement staff, PDA users, and platform domain participants. This same group may be instrumental in establishing personal area network connectivity standards and in evaluating the cost effectiveness of moving from IrDA to Bluetooth or other contenders for future wireless connectivity between networked PCs and PDAs (Bluetooth is not currently considered to be a cost effective option).

Personal Computing—Recommended Requirement 14: *The Enterprise Architecture team recommends that VITA conduct a comprehensive study of PDA needs, functions, benefits, and costs. The study team should include platform domain participants, network domain experts, PDA support and PDA users. The Enterprise Architecture team will use this information to recommend future PDA directions for the Commonwealth. Because PDA product and service offerings change frequently, this group should review its recommendations twice annually.*

The domain team presently recommends that agencies use the Blackberry/RIM device. This decision is based on presumed workforce needs and the desire to limit devices deployed to one type while providing both low-end and high-end service options. On the high-end, Blackberry provides the option of a Commonwealth controlled push email server. On the low end, the same device may be used without wireless services. If the Commonwealth is able to centralize email services, it may be able to cost-effectively provide wireless push email to users who were previously targeted for low-end PDAs. The setup of the device for both low- and high-end users is fairly simple. Blackberry also provides some interesting total cost-of-ownership categories that can be considered when Virginia designs its examination of costs.

Personal Computing—Recommended Requirement 15: *The Enterprise Architecture team recommends that all agencies use the Blackberry device for both low- and high-end PDA services until VITA completes a comprehensive study of PDA needs and costs.*

The Blackberry device has a useful feature set with or without the push email services for which it is known. The benefits of using the same device for low and

high-end services is reduced support staff training costs, transfer of customer skills for customers moving from low- to high-end services, proven implementation of high-end services in Virginia government, and anticipated cost effectiveness if offered to appropriate users as part of a planned tool set.

Additional Recommendations

Selecting Hardware Components

The domain team used advice from a ZDNet article[37] and other research in developing the component selection advice provided below. Please note that advice is geared to the computer needs of most state knowledge workers and is not intended for all users.

- Determine the OS and productivity software first (this information will be used in creating the base image for the average worker and will determine standard hardware needs). Consider the resource requirements of the current software versions and the manufacturer's historical pattern for resource usage increases accompanying version changes. The Microsoft Office 2003 upgrade, for example, requires larger memory footprints for new features.
- From a list of currently supported chipsets, either specify the lowest acceptable components or choose all chipsets that meet your minimums (the parts discussed below are integrated into one chipset).
  - Permit Pentium and Athlon to be contenders for the base contract; do not permit Power Mac G4 for the base contract unless the Commonwealth is undertaking a total change in directions.
  - Do not specify the highest available clock speed as a minimum.
  - Select a chipset with a lower speed processor with more cache rather than the one with a higher speed and less cache as the minimum (the cache, which is part of the chipset, will provide speed enhancements more noticeable to the user than those provided by processor speed).
  - Do not set a cache minimum that inadvertently eliminates a chipset from contention (e.g., the amount of cache will vary by brand, so choose the minimum from the brand with the lowest acceptable cache (e.g., P4s have 512K cache that is roughly equivalent to the 384K cache in the Athlon XP so select 384 as the minimum acceptable cache).
  - For PCI support, select the lowest standard in a currently supported chipset as the minimum (e.g., PCI 2.2).
  - Require USB 1.1 support or higher (higher versions are backwards compatible for ensuring peripheral connectivity).
  - Require ATA 100 IDE.
- The memory requirements are determined by the operating system, software and software use patterns. Information is generally available regarding the expected base

[37] ZDNet Technology Update, *Intel: Beyond Gigahertz,* Steve Kleynhans, December 18, 2002.

memory requirements for software upgrades, if any, that are anticipated during the life cycle of the computer. The memory acquired with the hardware should exceed the base requirements for any anticipated upgrades.

- Low-end, integrated video cards are adequate for meeting most business needs.
- Choose the hard drive that has faster access (e.g., 7200 rpm) and lower capacity (e.g., 20 GB) as a minimum (business users store information on a networked server and do not need a drive larger than one adequate to hold software and provide virtual memory).
- Integrated graphics are fine with adequate systems memory (RAM).
- Integrated audio is an adequate minimum for good sound on a business unit.
- The network adapter may be separate or built in to the motherboard, and should have at a minimum, 10 and 100 Mbps speeds. 10/100/1000 Mbps cards are available and may be cheaper than the 10/100 Mbps cards. The Commonwealth should acquire 10/100/1000 Mbps cards if they are of equivalent quality and less expensive even though use of Gigabit (1000 Mbps) connections are expected to be rare.
- A cost analysis may be needed to determine when it is acceptable to eliminate requirements for older PS/2 and parallel connections. After they are eliminated, it would be necessary to provide expensive converters to the few remaining people who need the ports.
- FireWire ports are not needed for most business users. Some I/O capabilities are more likely to be useful on servers than on desktops.
- Business machines are rarely expanded during their lifecycle. Providing for 1 to 2 open PCI slots, although often recommended, is a waste. The Commonwealth should encourage the acquisition of small form factor computers with no expansion slots.
- Business users do not need an Accelerated Graphics Port (AGP) slot. AGP slots/graphics cards will soon be phased out and replaced by PCI Express.
- CD RW and DVD ROM capabilities are a good idea. When standards are approved, DVD writing capabilities will be important. A standard base unit should not have DVD write capabilities at this time.
- Examine all new advances for their acceptability for use (e.g., whether they are useful for government business, whether they use adopted technical standards, whether they have moved beyond "bleeding edge," and whether they are proven or require further testing).

Commonwealth procurement staff should (and probably already do) use this type of approach to establishing base unit contracts.

Life Cycle for Hardware and Software

The life cycle for desktops and notebooks should be set at four years to correspond to what is presently happening in the business community. GartnerGroup states that this is a workable policy from the standpoint of business needs for all but some high-powered users[38].

Moving to a four year refresh could result in an immediate one-time savings for the estimated one-third of desktops scheduled for replacement during the first fiscal year if no desktops were refreshed during the first year. However, this solution would not be practical, because by skipping a year, no desktops would be ready for replacement four years later. The Commonwealth could choose to refresh some desktops early or some late in the process of moving to a four-year cycle. Table 6 demonstrates refreshing some earlier than four years and getting to a four-year refresh for all refreshes by fiscal year 2007 (see row two). In reality, some Commonwealth agencies have substantial numbers of computers that are four, five or six years old. For this reason, choosing the "refresh some early" method demonstrated in Table 6 would allow the targeting of outdated equipment in the first year.

Table 6: Example Savings Moving from a 3 to a 4-year Lifecycle for 60,000 Desktops

				Biennium		Biennium
		FY 2004	**FY 2005**	**FY 2006**	**FY 2007**	**FY 2008**
I	**Desktop units refreshed per-year with 3 year cycle** (20000 is 1/3 of executive branch desktops). 20,000 per year assumes a 3 year refresh and no desktops older than 3 years)	20000 Group A	20000 Group B	20000 Group C	20000 Group A	20000 Group B
II	**Desktop units refreshed per-year with 4 year cycle** (shows how VA might move to a four-year cycle for the A, B, and C groups above—early means before 4 years.)	15000 A:Early Refresh	5000 A: On Time Refresh 10000 B:Early Refresh	10000 B: On Time Refresh 5000 C:Early	15000 C: On time	15000 ¼ On time
III	**Decrease in number of desktop units refreshed each year** (Row I –Row II)	5000	5000	5000	5000	5000

[38] GartnerGroup, Desktop PCs—Technology Overview, 25 April 2003, Frederica Troni, "For mainstream users, enterprises can safely adopt a four-year life cycle for their PCs. Increasing the life span to four years reduces initial purchase costs, but other factors must be considered, including depreciation, licensing costs, extended warranty costs and the requirement for spare parts. For power users, a four-year replacement cycle is unlikely to be acceptable (presumably, due to needed improvements in business functionality).

		FY 2004	FY 2005	Biennium FY 2006	FY 2007	Biennium FY 2008
IV	**Estimated savings each year for Row III desktops** (new desktop cost ($1100), new desktop setup cost ($50), and old desktop disposal ($50) = $1200 per 5000 units)	$6M	$6M	$6M	$6M	$6M
V	**Estimated additional savings from monitor replacement policy** (If no monitors are replaced for 10 years, and if new monitors are flat panels, savings would be $300 per computer replaced. The FY2004 monitors are 3 years old and will not be replaced until 2012. No monitors will be replaced until 2012.)	$6M	$6M	$6M	$6M	$6M
VI	**Estimated total desktop savings for moving to 4 year cycle** (Row IV plus Row V)	$12 M	$12 M	$12 M	$12 M	$12 M

Table 6 also provides estimated cost savings. Under a four-year cycle, the Commonwealth would save an estimated six million dollars per year by refreshing 5000 fewer desktops each year. The Commonwealth would also save an estimated six million dollars per year by not replacing 20,000 monitors each year. This savings would continue for about six years and then decrease to a savings of about $4.2 million.

> ***Personal Computing-- Recommended Requirement 16:*** *Enterprise Architecture recommends that agencies including the administrative units of higher education change the desktop lifecycle to four years for one full year beginning in the 2004 Fiscal Year. During this year, VITA can study support costs for a sample of the four-year-old machines and determine whether annual support cost increases offset annual savings from reduced acquisitions. VITA can then recommend either a return to a three-year refresh cycle or continuance of the four-year refresh cycle following the study.*

Currently, many agencies refresh operating systems and productivity suite software during the lifecycle of the computer. There are good reasons for doing this, especially in an agency centric support environment. This helps agencies to keep current and reduce support complexity. However, in an environment where support teams may serve several agencies,

there may not be a compelling business reason to upgrade. Because Microsoft's license costs are a concern, it may be more cost effective to skip upgrades whenever possible. Because future licensing costs and requirements are an unknown, the Commonwealth may not be able to realize a savings by eliminating upgrades. An example problem is whether new versions are backwards compatible for four years worth of revisions. Because there are so many unknowns that must be weighed for a particular cohort of computers and software, this recommendation is listed as an optional best practice.

> ***Personal Computing--Optional Best Practice 6:*** *Enterprise Architecture recommends that agencies and central services do not upgrade operating systems software or office productivity software during the life of the desktop.*
>
> *One concern about using this approach is that support staff may have to support many versions. The organizing of personal computer support teams by OS/software version combinations rather than by agency may mitigate this problem. This would also facilitate the tracking of problems by version of software and year of hardware.*

Outsourcing

The value of outsourcing desktop and notebook solutions should be reevaluated annually, even if multi-year seat management contracts have been signed. The market place is constantly changing, and the value of outsourcing changes with it. A change of the desktop refresh rate from 3 to 4 years should be reflected in any re-evaluation.

> ***Platforms Generally--Optional Best Practice 2:*** *VITA should include opportunities for annual renegotiations in all high-volume outsourcing contracts to ensure that outsourcing remains cost-effective as market and other conditions change.*

Technical Topic #2: Servers

For this discussion of Virginia's Enterprise Architecture, the terms high-end servers and midrange/low-end servers are used to categorize agency and central servers. The high-end servers are those that scale beyond 16 processors, typically including large UNIX machines and mainframes. How these servers combine processors and access memory to achieve scalability and availability is one important defining characteristic. For example, servers included in the high-end category might be symmetric multiprocessing servers (SMP), massively parallel processing servers (MPP), non-uniform memory access servers (NUMA), or SMP-NUMA combinations. Another typical feature is the ability to provide dynamic hard partitioning of resources.

All one to eight processor servers and many that scale only to 16 processors are in the midrange to low-end group. Servers that are pared-down versions of high-end machines could be placed in either group depending on restrictions placed on their scalability and access to high-end functionality.

When considering platforms for consolidation, Virginia may consider high-end platform capabilities for a group of applications or utility services of interest. Another approach is scaling out by adding servers to clusters or farms rather than scaling up by adding resources from within a server. For consolidations, scaling up will likely occur on one or more high-end platforms. The scale-out groupings are typically made up of servers in the low to

midrange category but could be clusters of virtual servers on a high-end server as well. The grouping capabilities may be provided by operating systems, software associated with blade frames, or third-party software.

The typical midrange to low-end server in the Commonwealth would have a base cost between $3,000 and $50,000. Of course, the cost can go higher if you add enough memory, operating system optional capabilities, and other features. High-end servers sometimes have a "start small" option that can take them into a lower price range, but prices greater than $250,000 would be more likely.

The Commonwealth's midrange to low-end server strategy could focus on improving service levels, improving operating system uniformity for types of work typically performed, providing central management of remote servers, providing centralized management of servers in high-density configurations within the data center, reducing the cost of application provision, or providing opportunities for cost-effective workload consolidation. The Commonwealth's high-end server strategies could focus on architectural simplification, having a mainframe strategy, having high-end UNIX strategy, reducing use of proprietary OSs, or planning for future scale-up solution management alternatives for Windows. Also, for both server groups, support for Linux is an important consideration. For both the low to midrange and high-end server groups, having architectural options for addressing foundation utility services and enabling flexible provisioning for applications are important business requirements.

In the spring of 2003, Governor Mark L. Warner signed a bill that requires VITA's consolidation of servers in executive branch agencies. However, the consolidation mandate excludes higher education executive branch agencies. Even though the enterprise architecture discussion in this report will apply to the business side of higher education, little data is available at this time regarding the present architecture for business and backend servers for Virginia's colleges and universities.

To provide as good a picture as possible of the "As Is" architecture, discussions below will separate out higher education when data are available to do so. In addition, when possible, data will be broken out by the midrange to low-end servers and high-end servers. Because the available information on servers does not include the number of processors, the placement of servers in the high-end group has been decided by using model name.

Some background on server consolidation may be helpful for understanding the "As Is" architecture and proposed future platforms in relation to consolidation options. There are several approaches to server consolidation. GartnerGroup suggests the following three approaches (consolidation types in italics are and basic definitions are from GartnerGroup).

- The first type of consolidation, *logical consolidation*, leaves servers where they are and manages them centrally. This is a likely first phase for consolidation. The management software should handle well the types of servers in the current and envisioned future architecture. This type of consolidation applies more to Virginia's low-end to midrange application servers.
- The second type, *physical consolidation*, requires moving agency server hardware to one or more central locations to be managed across groups of agencies or co-locating replacement hardware as existing servers become obsolete. In Virginia, this

consolidation solution would also require good telecommunications for getting the data and functions to the users in addition to a good central management strategy. This type of consolidation may be appropriate for Virginia's low and midrange servers as equipment is replaced.

- The third type of consolidation, *rationalized consolidation*, requires using scale-up and scale-out consolidation platforms for the co-location of applications, network functions, and utility functions. Collocation of such applications might involve using provisioning blade frames, clustering servers, partitioning servers, virtual servers, etc.

  Rationalized consolidation might include bringing together many different applications to one platform or consolidating multiple instances of the same utility application such as email. This type of consolidation is the most risky and, therefore, requires additional attention to assessing risks for the alternatives being compared. Different consolidation platform strategies may be appropriate for different utilities or for applications running on different OSs (i.e., Windows, UNIX, Linux or other operating systems).

Virginia's "As Is" Architecture for Servers

For fiscal year 2002, Virginia's executive branch agencies excluding higher education report having 2,997[39] servers. Fewer than 80 of the 2,997 servers appear to fit the Commonwealth's high-end server definition, and only three of these are mainframes.

High-end Servers

Virginia has two mainframe technologies that are centrally supported and available for agency use, IBM zOS and Unisys HMP OS2200. In addition, the Virginia State Police (VSP) support a Unisys OS2200 midrange system for their use and the Department of Agriculture and Consumer Services (VDACS) supports an IBM VM mainframe for their systems. As with all high-end servers, developing applications to run on these computers is more costly than it is for midrange and small servers. What high-end servers offer in return are dynamic partitioning, high availability, high security, and high performance.

High-end UNIX servers are approaching or equaling mainframes in all capabilities. As a result, mainframe companies (e.g., IBM) have reduced selected licensing and other costs to improve the price/performance quotient relative to other high-end platforms. High-end computers generally have a proprietary operating system or a type of UNIX operating system with code differences across types of UNIX that are supported by the manufacturer.

The Unisys mainframe that is supported centrally is model CS-7802 HMP ClearPath. Its OS2200 operating system was originally from Sperry. The platform supports dual domains, which are fully sufficient subsets of the system, and which do not share components (other than the cabinet). Partitions run in the domains, with each running its own copy of the operating system. The Commonwealth's Unisys server can support up to four partitions and 32 processors. The Unisys has the ability to run 32-bit or 64-bit Intel processors simultaneously with the CMOS processors, thus providing a scale-up option for Windows Datacenter solutions if space is available to do so.

[39] Four of the servers reported as single servers are 100 blade frames. Fewer than one hundred of the 2,997 are "high-end" servers.

The Commonwealth supports two high-end IBM 9672 servers for central use. One has activated four of 12 possible processors and the other, five of 12.

Present Central IBM and Unisys usage information is provided in Table 7 below.

Table 7: Mainframe Usage

	IBM	Unisys
Data Owning Agencies	14	6
Customer Agencies, Boards, Commissions	180	203
Concurrent Users	6500-7500	2000-2500
Daily Transactions	3.0-3.5 Million	2.0-3.0 Million

Seventy-four servers, including the four mainframes, have been identified as likely high-end candidates based on make, model, and operating system information. No information is available regarding the number of processors currently employed in these servers. Of the 74, UNIX variants account for 54% percent, VMS—28%, MPE—9%, and OS400—3%. The remaining 5%[40] of identified servers are the previously discussed mainframes. Information about these servers is provided in Table 8 below.

Table 8: Agencies and Applications on Virginia's High-end Platforms

Virginia's High-end Application Platforms	OSs	Agencies	Agency Count	Server Counts: Apps Reported + Apps Not Reported	Unique Application Count[41]
IBM S/390 9673-Y 46 and 9673-Y 56	zOS	VDOT, DSS, DPB, DHRM, SBE, DOA, TRS, DMV, SCB, VRS, TAX, SCC, VEC, DOC	14	2 + 0	67
Unisys CS7802 HMP ClearPath	OS2200	DSS, DHRM, DHRM, BOE, SCC, DIT, DMV	6	1 + 0	41
IBM ES9000 mainframe, 9221, model 150	zVM	VDACS	1	1 + 0	31
IBM AS400	OS400	DCJS, DRS	2	2 + 0	2
IBM RS/6000	UNIX: AIX	JYF, DMAS, SMV, VDOT	4	13 + 5	32
Sun	UNIX: Solaris	DSS, DMV, DHRM, DEQ	4	6 + 9	34
HP	UNIX: HPUX	DMAS, TAX	2	5 + 0	18

[40] The percentages do not total to 100 due to rounding.
[41] Not all agencies linked their business applications to servers. The application count is an underestimate of the applications running.

Virginia's High-end Application Platforms	OSs	Agencies	Agency Count	Server Counts: Apps Reported + Apps Not Reported	Unique Application Count[41]
DEC	UNIX: Digital	LOV	1	2 + 0	2
HP/Compaq/ DEC	VMS	DOC, DPOR, VDOT	3	20 + 1	10
HP3000, 9x9, 9x8	MPE	DMHMRSAS	1	7 + 0	27

Notes:

The application counts are an underestimate of the total applications supported. Some applications run across high-end platforms. Only production servers are counted. Fifty-nine of the 74 servers above are linked to business applications in the Due Diligence database; fifteen servers have no business applications associated with them.

Virginia's high-end UNIX platforms are primarily Sun, Hewlett Packard, and IBM. VMS and MPE servers also have strong representation. UNIX is the dominant operating system at the high end for server counts and supported business application counts.

Midrange to Low-end Servers

The majority of servers in Virginia's executive branch agencies are midrange to low-end (more than 2,900 servers). Looking at data across all servers, the characteristics of the low end will dominate due to the high percentage they represent in the server pool. This is true in Figures 2, 3, and 4 and in Table 9 below, which use Due Diligence project data on all servers reported by executive branch agencies (excluding higher education) for the fiscal year ending June 30, 2002.

All Servers

Figure 2 displays the 6,005 uses reported for the 2,997 servers (low to high-end) reported by executive branch agencies. Figure 3 shows the manufacturers that have supplied the majority of servers.

Figure 2: Server Use in Virginia's Executive Branch (excluding higher education)

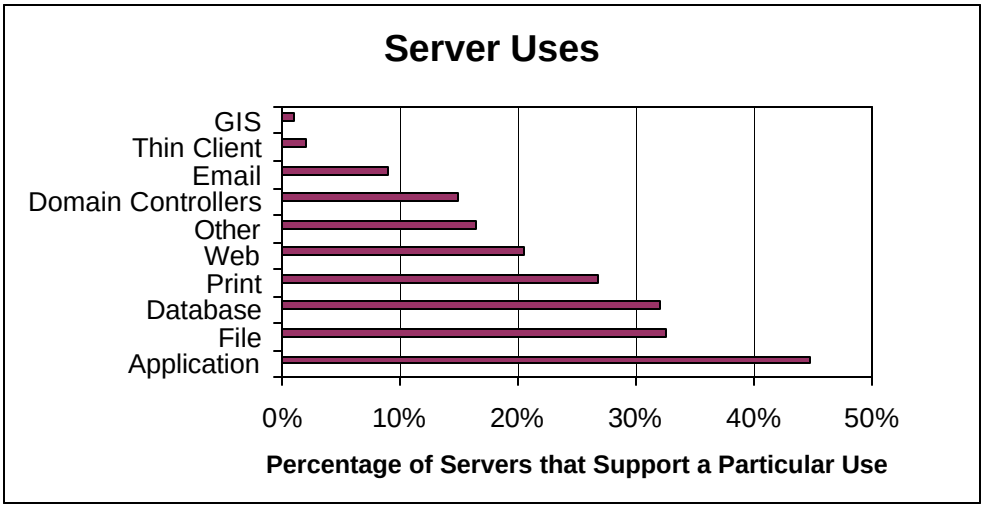
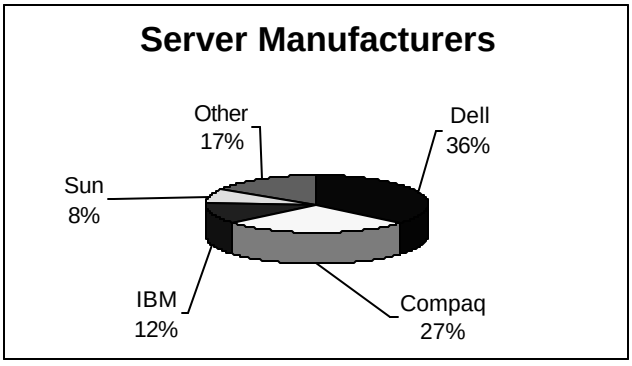


Figure 3: Server Manufacturers for Servers in Virginia's Executive Branch (excluding higher education)



Note: Other includes manufacturers with one to three percent and unknown manufacturer.

Figure 3 shows that 75% of all servers in use in fiscal year 2002 were Dell, Compaq or IBM. Table 9 shows that these three manufacturers have accounted for at least 81% of server purchases in the last five years. Sun was a major player six years ago because of the acquisitions made by one agency. Similarly, IBM's dominance in 2002 was due to acquisitions by one agency. Dell and Compaq, on the other hand, are consistently acquired by most agencies across the last five years. Only 73% of servers are known to be five years old or less.

Table 9: Server Manufacturers By Year for Servers in Virginia's Executive Branch (excluding higher education)

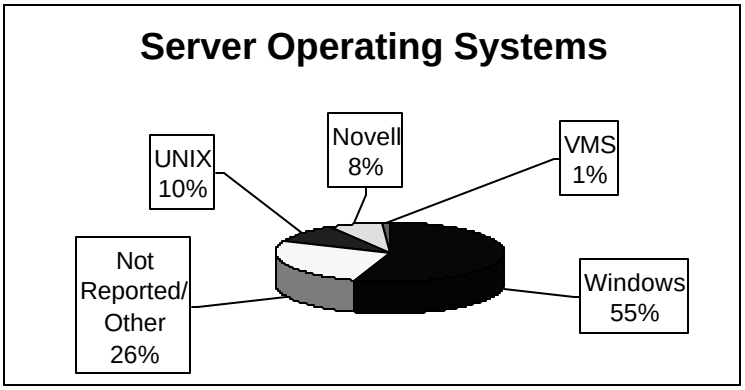
Purchase Year	Dell	Compaq	IBM	Sun	Other	Total
Year Not Reported	113	222	7	38	74	454
1987		1			2	3
1989					2	2
1991				1	7	8

Purchase Year	Dell	Compaq	IBM	Sun	Other	Total
1992			1		2	3
1993	1				1	2
1994				1	12	13
1995	7		1	3	6	17
1996	8	19	8	2	44	81
1997	50	53	1	**103**	22	229
1998	**147**	59	6	13	29	254
1999	**277**	79	9	27	121	513
2000	**199**	120	40	22	119	500
2001	147	**183**	14	21	33	398
2002	147	74	**267**	8	24	520
Grand Total	1096	810	354	239	498	2997

Note: the bold number in a row indicates the most prevalent manufacturer for the year; in 1997, one agency acquired most of the Sun servers; in 2002, one agency acquired most of the IBM servers

Operating systems reported by agencies are shown in Figure 4. Windows operating systems are reported for over half of the servers.

Figure 4: Operating Systems in Virginia's Executive Branch (excluding higher education)



About half of the Windows OSs are Windows 2000 or Windows 2000 Advanced Server and the other half are Windows NT. The UNIX servers are predominantly Solaris and Linux. Novell operating systems are most likely to be Novell 4.x.

Servers Providing Network, Email, File or Print Services

In Virginia's current architecture, 446 servers are reported to be domain controllers[42] or providers of network services. In many instances, the servers function in additional capacities including providing file, print, email, database, and other services. In part, this functional mixture is due to having one server that provides everything in small agencies. For the

[42] The term domain controller is a Microsoft term. Novell and others use different terms to describe their network services. Services may include domain control (PDC, BDC), remote access or RAS, IP address assignment and domain name services (DHCP, DNS), directory services (NDS, Active Directory), file and block storage (NFS, NSS) and other resource cataloging, structure defining, and resource access functions.

servers reported as network service providers, 94% have Windows[43] OSs (i.e., NT Server, 2000 Server, and Advanced Server).

For e-mail, the majority of agencies use Microsoft Exchange. The executive branch agencies report 268 email servers in use in FY 2002.

Commonwealth's Goals for the Server Architecture

In the past, server solutions have been proposed agency by agency rather than from the perspective of the Commonwealth as a whole. Somewhat different goals are important for these two perspectives even though needs of the business application remain the number one concern.

A Commonwealth perspective would focus on the following enterprise-wide goals:

- Achieving cost-reductions across agencies while maintaining or improving service quality for each agency
- Providing new/improved services across agencies
- Ensuring fit with the Enterprise Architecture to guide the Commonwealth towards future efficiency and effectiveness targets.

The typical Commonwealth-level solutions pursued to achieve these goals include:

- Considering consolidation of platforms across agencies
- Considering platforms as application consolidation vehicles
- Considering more homogeneous server solutions across agencies (e.g., reducing the number of OSs, images, manufacturers, management solutions, etc.)
- Considering opportunities for reuse of software, hardware, and server images across agencies
- Considering alternate organizational and staffing arrangements across agencies to reduce costs and improve service consistency and quality
- Grouping certain functions for common handling across agencies to improve cost effectiveness or services (e.g., email or help desk functions)
- Considering outsourcing or central in-sourcing opportunities for all IT services
- Considering multi-agency storage alternatives to reduce escalating server acquisition costs
- Considering server size tradeoffs

  When a server's size (or committed resources in the case of virtual servers) is just right, this will increase the likelihood of high server configuration costs and server resource monitoring costs. Having a server that is too large might decrease monitoring costs while wasting resources and limiting future opportunities to enhance server performance by acquiring improved technologies.

[43] Virginia's Microsoft Windows domain controllers were mainly NT (n=266) in 2002.

Agency-focused decisions have a narrower focus. Agencies may have the following within-agency goals.

- Achieving cost-reductions within the agency while maintaining or improving service quality
- Providing new/improved services
- Ensuring fit with agency architecture requirements
- Ensuring fit with support staff capabilities within agencies for equipment to be managed internally

Typical agency-level solutions pursued to achieve these goals may include:

- Considering opportunities for reuse of software, hardware, and server images within the agency
- Considering more homogeneous solutions within the agency (e.g., reducing the number of OSs, manufacturers, management solutions, etc.),
- Considering alternate organizational and staffing arrangements within the agency
- Considering outsourcing to a central service or an outside provider

When designing application-specific server solutions, the following opportunities are pursued to achieve goals related to business needs and cost parameters regardless of whether agency or central solutions are being entertained.

- Considerations in making server choices for applications supported within or across agencies
    - Taking advantage of vertical scalability—the ability to do more work faster based on hardware component selections
    - Taking advantage of horizontal scalability—the ability to combine like components to improve speed, performance and availability (called sysplexing in the mainframe world and clustering in the midrange to low-end server world)
    - Understanding the limits of hardware and software options when making decisions
    - Taking advantage of specialized OS capabilities when needed (e.g., see technologies row in Table 10 below)
    - Considering the match between server solution opportunities and application- or enterprise-related security needs
    - Avoiding server bottlenecks that have an impact on application service levels within or across agencies
    - Ensuring serviceable systems to meet application availability requirements
    - Considering specific company and industry directions for hardware and software for assessing long-term solution opportunities

  - Considering the potential effect of future mobile access trends and other trends that better enable assessment of related provider directions for server hardware and software

- Considering expectations and metrics for the total solution
  - Ensuring adequate reliability
  - Ensuring adequate availability
  - Controlling costs for the application and its future maintenance
  - Involving agency security and network personnel in solution decisions from the beginning

Issues/Challenges

There are a number of issues and challenges that must be dealt with in providing good application-based, agency-based, central, and outsourced server solutions. Some of these are noted below.

- Estimating solution risks for platform alternatives
- Estimating costs and benefits for platform alternatives
- Ensuring fair and equitable charge-back mechanisms for multi-agency platforms and related services
- Providing for competition while controlling overall architectural complexity
- Defining models for allocating these costs across the systems and services that use them

  Some cost-effective consolidation solutions require up-front expenditures to ensure solution opportunities (e.g., acquisition of a consolidation platform) or related services (e.g., authentication, access, connectivity, management software, bandwidth, help desk services, and operating metrics). Whenever these services are shared across consolidation opportunities, a method of using part rather than all of the costs in an alternative comparison will provide a better assessment of the consolidation opportunity.
- Promoting the benefits of having a platform architecture through customer communications
- Ensuring that architecture recommendations have an impact on procurements

Technology Component Trends

Overview

The purpose of presenting server technology component trends is to provide acquisition guidance and acquisition requirements. In some cases, the guidance addresses those server technologies that are changing. In other instances, the guidance is related to architectural preferences for the Commonwealth. To provide this guidance, it is necessary to break servers into the software and hardware pieces that together form the total solution offered by the

manufacturer. Table 10 below presents selected server technology component trends as of mid-2003 and rates the components as obsolescent, transitional, strategic, or emerging. The strategic column in Table 10 indicates which server-related technologies, if needed by the business application, are presently recommended as components for acquisition within the Commonwealth's Enterprise Architecture. Not every component is listed, but the most important components that are changing due to technical advancement or due to support elimination are included. Also included are those technology components involved in Virginia's architectural simplification plans. Platform operating systems are discussed from the perspectives of both consolidation and simplification.

Architectural simplification will help Virginia in providing a more unified central management and in ensuring proper staffing. Movement to a more simplified architecture, however, will initially result in staff retraining and systems migration costs. Simplification will occur over a long period of time as applications and platforms are replaced. Simplification taken too far, however, could eliminate competition for the Commonwealth's business or limit participation in new future directions. A lack of competition could result in high acquisition and maintenance prices or could limit the Commonwealth's ability to take advantage of the selected advances that may solve a particular problem. Recommendation for simplification provided in Table 10 attempt to preserve competition while promoting a simpler, more unified architecture for the Commonwealth.

Interconnects

Interconnects (see row 1 of Table 10) are very important technologies for defining server architectures. Both internal and external interconnection technologies are changing. Two future developments will be heavily influenced by interconnects. One is the rise in modular scaling architectures, especially in the midrange, and the other is Intel and AMD competition with the RISC processors used by IBM, Sun, HP, and others. New interconnects are needed to overcome the bottleneck caused by the use of PCI bus (bridge) architecture in Intel and older AMD chipsets that prevent effective scaling beyond four processors. Also, new interconnect strategies are needed to string the modular components together without creating new bottlenecks between components. Modular designs, whether CISC, EPIC, or RISC, will compete with the higher-priced midrange machines that are downsized versions of the high-end platforms.

Modular designs are already flooding the marketplace. Sun and HP were among the first to offer this architecture. GartnerGroup notes that use of serial, switched fabric architectures (popular components of Storage Area Networks) such as Intel's InfiniBand interconnect will enable moving the server's I/O out of the box and into shared hubs[44]. This will be the rule in single servers and in blade frame solutions. Egenera is an early adopter of this approach in the blade arena. A competing technology for the switched fabric is 10 Gigabit Ethernet (10GigE). GartnerGroup believes that the InfiniBand will be used for serial interconnect fabric for component interconnects and 10GigE, for the blade servers. GartnerGroup also argues that the changes will begin with "in the box" I/O changes.

[44] Unix Midrange Servers: Overview; Gartner Research, DPRO-89827; IAN Brown; July 31, 2002.

For internal connections, many current low-end and midrange servers now use a PCI-X bus architecture, which is a parallel, shared architecture. An alternative to the PCI-X architecture is called PCI Express (formerly 3GIO), which is a serial point-to-point architecture[45].

Connections from one processor to another processor, from one multiprocessor board to another, from a processor to a memory controller (or other shared resource), or from a processor to another internal or external component are examples of potential bottlenecks in multiprocessor servers. One example technology to improve connections of these types is AMD's HyperTransport, which AMD used in its new AMD Opteron chipset. HyperTransport is also proposed for connecting multiprocessor boards and for linking to Gigabit Ethernet, InfiniBand, and legacy PCI bridges.

NUMA architectures have recently undergone a major change in how memory is accessed. The change was from *serial-ring* non-uniform memory access (NUMA) to the current *crossbar* access. This Sun design was revolutionary in enabling high-end and midrange UNIX platforms to support transaction processing with multiple processors with low and evenly distributed latency across processors. Connection of processors in a serial ring ensured that some were further from memory than others. This made it impossible to scale up without introducing greater and greater latency as processor counts increased. The crossbar approach provides more even interconnects and is also faster than the ring approach. This was a major force in making high-end servers competitive with servers previously classed as mainframe.

Servers—Optional Best Practice 1: *Virginia should determine if cost savings can be realized by identifying and replacing any serial ring NUMA platforms.*

For Intel architecture 32 bit chipsets (e.g., Xeon MP processors), even when multiple processors are sold as a unit (e.g., 2-way, 4-way and 8-way processing units), there is a problem with slow memory access, slow cache coherency (e.g., updating via snooping), and slow communications among the processors. This is because the Intel type processors all use one shared bus for all of these functions. Essentially, because the bus is shared, the bandwidth for a four-processor unit is one-fourth the bandwidth for a one-processor unit. The architecture does not include the crossbar interconnects that are so critical to speed and scaling. Intel's next step in addressing this bandwidth problem is using PCI Express.

AMD has made greater advances than Intel in improving memory access speeds and other access in its 64-bit Opteron solutions by using HyperTransport, PCI-X Tunneling and unidirectional links. The two-processor version of Opteron was released in April of 2003.

For connections between components and/or between low-end servers, technologies including InfiniBand and Remote Direct Memory Access (RDMA), which borrows heavily from InfiniBand development work, are supported by competing groups of manufacturers. According to CNET, "While RDMA will arrive later and perform slower than InfiniBand, it will have the advantage of using conventional networking hardware based on the TCP/IP and Ethernet standards used to build the Internet.[46]" Microsoft[47], HP and others feel that RDMA,

[45] Intel will produce chipsets with PCI Express later this year. PC Magazine, *The Ins and Outs of New Local I/O Trends.*

[46] Server makers tout InfiniBand sequel, Stephen Shankland, CNET News.com, June 5, 2003, http://asia.cnet.com/newstech/systems/0,39001153,39129187,00.htm

which allows one computer to read from or write to the memory of another directly without going through the operating system and other layers of software, will be the technology that will make it possible, from a performance standpoint, to make scaling out on low-end servers connected to 10 Gigabit Ethernet competitive with scaling up on high-end servers.

> ***Servers—Optional Best Practice 2:*** *For its high-end symmetric multiprocessing needs, Virginia should use only servers that employ NUMA and similar proprietary high-end interconnection solutions until Remote Direct Memory Access (RDMA) and other future technologies become enablers of competitive scale-out solutions.*

Technologies

The Technologies row in Table 10 lists the most useful of the hardware, OS, and add-on capabilities available today to support server resource provisioning, availability, scalability, recovery and management. These are the capabilities that are likely to be natively provided on the high-end servers and provided in some instances as third-party add-on capabilities in some midrange to lower-end servers.

Table 10: Technology Use Trends for Servers[48]

Obsolescent	Transitional	Strategic	Emerging
Interconnects Serial Ring NUMA; ccNUMA	**Interconnects** PCI 2.2, PCI X 1.0	**Interconnects** Crossbar NUMA/SMP-NUMA architecture for midrange to high-end PCI Express, PCI-X 2.0 and PCI 2.3 HyperTransport (AMD's point-to-point link for interconnecting integrated circuits on a board) Other current high-end server internal interconnection technologies including proprietary methods	**Interconnects** InfiniBand RDMA and 10GB Ethernet will blur lines between servers and their resources on networks 10GigE for blade servers Serial switched fabric for modular servers (e.g., InfiniBand, HyperTransport)
	Technologies for Server Management & Consolidation Virtual Machine Creation	**Technologies for Server Management & Consolidation** Workload Management Software for high-end and some midrange for increasing resource	**Technologies for Server Management & Consolidation** Geographic Failover

[47] WinHEC 2003 Technology and Platform Advances Sessions—Summary: Microsoft states: "While TCP offload engine (TOE) NICs can achieve good performance over 1-Gigabit Ethernet in many situations, RDMA will be required for a complete offload solution and to realize the full performance potential of 10-Gigabit Ethernet."

[48] Requirements in this table apply to executive branch agencies, including the administrative units of higher education.

[49] Provisioning blades are new technologies from Sun (N1-Provisioning Blades)

Obsolescent	Transitional	Strategic	Emerging
	Software for transitional support of OS environments not in the strategic architecture	usage efficiencies (Native and 3rd Party) Virtual servers (resource provisioning across applications) and virtual machines (server partitioning for different OSs or multiple OS copies): available for servers and blade solutions; use of resource provisioning for increasing resource usage efficiencies; use of virtual servers in partitions for reducing licensing costs on IBM zOS via Linux use; use of partitions for creating segmented development, testing, training, etc. environments by running multiple OS copies. Hardware Partitioning via OS (Static and Dynamic) dynamic permits ease of resource provisioning changes Fault tolerance via design redundancy and hot swapping Clustering; Parallel Sysplex for IBM mainframe Load Balancing Remote Management Blades (not proven for all types of uses) Provisioning Blades[49] Blade repurposing/Image distribution	(emerging due to costs) Hyper-threading (HT); simultaneous multithreading (SMT) switched multi/single threading ; (CMT) chip multithreading (not yet fully tested or in development). Dual core chips with multithreading Network is Server (managing resource sharing)

Obsolescent	Transitional	Strategic	Emerging
Consolidation Platforms *Scale up: midrange to high-end platforms* MPE MVS OS 390 Unisys OS2200 VMS OS/400 IBM ES9000 (9221) AIX	**Consolidation Platforms** *Scale out: Virtual Servers* Permit Windows NT as a transitional strategy Permit virtual servers of older versions of supported OSs in transitional efforts	**Consolidation Platforms** *Scale Out: Virtual Servers/Virtual Machines* Permit Windows, Solaris, HP-UX, or Linux virtual machines and virtual servers in scale out solutions provided via zVM, Connectix, or VMware. *Scale out: 32 bit CISC (IA); 64 bit RISC;IBM high-end virtual servers—farms/clusters using blades, server appliances, and servers* Permit Windows, Solaris, HP-UX, and Linux as candidates for acceptable uses Appropriate for MS Exchange Server (Email Farm): clustered low-end to low midrange solution on Windows Server 2003 Enterprise (upon testing). Note: Active Directory as directory of choice if MS Exchange e-mail solution used. Appropriate as tier for single large databases—e.g., Oracle real application clusters (RAC). Appropriate for Web hosting: (e.g., on Windows Server 2003, UNIX or Linux) *Scale up: midrange to high-end platforms* Permit Windows, UNIX and zOS as candidates for high-end and midrange consolidation (Windows may not compete seriously until 2006 according to GartnerGroup[50]) Appropriate for critical application and database tiers Recommend DBs to run on separate tier from the applications they serve (platform or partition that does not include the application). *All new platform hardware* Regardless of manufacturer, if not currently in use in VA's architecture, architectural fit must be examined and cost/benefits studied	**Consolidation Platform** *Scale out: 64 bit EPIC (Itanium)* Use after applications retooled and after proven cost effective (highly cautious use). e.g., for SQL DB—next version is 64 bit (Yukon) e.g., for MS Exchange—next version (Titanium) is still 32 bit but following version will be 64 bit (Kodiak). Note: 32 bit applications may not run as well on 64 bit servers even though the chipset is backwards compatible. Note: Virginia's IBM mainframe has not been upgraded from 32-bit to 64-bit processing. The current IBM applications and anticipated future needs on the mainframe do not require the improved addressing capabilities.

[50] GartnerGroup, Unix and Windows Datacenter Enterprise Servers. Technology Overview, July 1, 2003; "The availability of these 64-bit servers, 64-bit versions of Windows Server 2003 and, crucially, a 64-bit version of Microsoft's SQL Server database management system (DBMS) is expected to increase the competitiveness of Windows as an alternative to Unix. It will certainly prove a challenge to RISC/Unix in terms of initial hardware

Obsolescent	Transitional	Strategic	Emerging
High-End Servers MVS XA MPE	**High-End Servers** MVS OS 390 Unisys OS2200 VMS OS/400 (library OS) UNIX other than Solaris and HP-UX IBM ES9000 (9221) Virtual servers of older versions of a strategic OS	**High-End Servers** z/OS, Solaris, HPUX, and Linux only Virtual Server OSs (e.g., zVM, Connectix, VMware) strategic only for supporting OSs that are in the desired future architecture (e.g., Linux, Windows 2003, and UNIX) Virtual server use to aid in building test environment setup IBM zOS, Sun Solaris, and HPUX RISC platforms are strategic. Hardware alternative to the above three platforms may be considered only if they are fully compatible, provide equal or better performance for all application and architectural requirements, and introduce no problems to the Virginia architecture other than those that may be cost-effectively resolved.	**High-End Servers** Windows Datacenter (both 2000 and 2003 versions) will not be strategic initially due to lack of data on its effectiveness, but the 2003 version will move to strategic by 2005 when more applications can take advantage of 64 bit chipsets Several Intel/AMD platforms will be candidates including IBM, Sun, HP, and Unisys platforms

and software acquisition costs, although the lack of ISV applications ported to the 64-bit Windows platform, skepticism about Windows security and less advanced manageability will retain the balance in favor of high-end RISC/Unix until at least 2006 or 2007 (0.7 probability). Windows also faces its own price/performance challenge from Linux and Oracle 9i RAC clusters. Initially running on four-way IA-32 nodes, three- or four-node Oracle RAC clusters running on four- or eight-way Itanium-based servers could offer a price/performance challenge to high-end Windows that is more in keeping with the small-server Windows ethos. Oracle RAC clusters could provide an even greater price/performance challenge to Unix SMP, however."

Obsolescent	Transitional	Strategic	Emerging
Midrange/ Low-end Servers NT 3.51 Novell earlier than 4.x	**Midrange/ Low-end Servers** NT 4.0 Novell 5.x—6.x OSX Novell 4.x and earlier Virtual Server OSs (e.g., Connectix, VMware GSX and ESX) enable transition strategies for multiple versions of the same OS such as NT and 2000 Windows MS Exchange servers	**Midrange/ Low-end Servers** Windows 2000, Advanced Server, (especially for domain controllers, file, print, and email) Windows Server System (2003 Standard and Enterprise Editions) –begin use with outwardly facing servers for security improvements and in clustering solutions. Datacenter with 32 bit processors only (if track record for the solution indicates cost-effective) Solaris and HPUX are candidates for high-end and midrange business Virtual Server OSs (e.g., Connectix, VMware GSX and ESX) become critical part of consolidation strategy and aid in test environment setup Linux (especially for Web) Server appliances can be highly cost-effective for cache, web serving, storage, and other purposes Traditional servers in racks remain strategic Server blades are slowly becoming contenders All manufacturers compete for midrange hardware.	**Midrange/ Low-end Servers** Windows Datacenter (both 2000 and 2003 versions) will not be strategic initially due to lack of data on effectiveness, but the 2003 version will move to strategic when proven
		Role of Linux on Low to High-end Platforms Linux as a database OS (e.g., Oracle runs on Linux) Linux as an application OS, initially for selected utilities including web hosting running on low end servers or in soft partitions on midrange or high-end servers (if possible following lawsuit) Linux for selected business applications Note: Use of open source free software may pose a risk to the Commonwealth that could be avoided by adopting an industry supported version such as Red Hat	**Roll of Linux on Low to High-end Platforms** Linux for business critical applications Linux as the managing OS or host OS for multiple partitions or multiple servers in a cluster or frame

In the past, mainframes have had many more OS-provided and proprietary tools for producing solutions that are reliable, available, secure, failsafe, efficient, powerful, horizontally scalable, vertically scalable, responsive, and self-managed. In recent years, high-end servers have sported as many of these capabilities as mainframes. Midrange servers that

are paired-down versions of high-end UNIX servers typically have the same capabilities as their high-end counterpart.

> ***Servers—Optional Best Practice 3:*** *Virginia should control the number of different management systems, third-party management solutions, and OS management vehicles used in providing both scale-up and scale-out consolidation solutions.*

Consolidation Platform Candidates

Row 3 of Table 10 discusses the roll of various operating systems in future consolidation efforts. Strategic contenders for consolidation platform solutions include both scale-up and scale-out solutions. Also included are virtual servers and virtual machines. For a particular consolidation effort, planners might consider either scaling up on a midrange to high-end server or scaling out on a collection of commodity servers, server blades, server bricks, server appliances, or virtual servers. From a cost perspective, the large server will generally have a higher cost of ownership than the simple server farm or server appliance farm. The more high-end capabilities and redundancies that are added to the farm, the higher the cost will be.

Several OSs are listed in the obsolete category. These are not viewed as contenders for high-end consolidation platforms either in transitional roles or as final platform solutions. The placement of platforms in this category is for simplifications reasons for Unisys OS2200, VMS, OS400, and AIX and for obsolescence reasons for MVS OS/390 and MPE. (Note: these OSs are listed here as obsolete for consolidation scale-ups. Their technology ratings may be different for legacy application support.)

Sixty-four bit Itanium-based platforms are not considered to be strategic for consolidation at this time. Several concerns contribute to this decision. First, there are few applications that make use of 64-bit addressing. Next, there is some concern about the heat generated by the Intel chipsets and the affect of the heat on their utility in blade frames and other high-density configurations. In addition, even though the new Intel chips are backwards compatible and can run applications designed to run in 32 bit architectures, they may have poor performance running 32 bit applications and do not support 16 bit applications (use in Virginia is unknown at this time). It is likely that this technology will move to the strategic category by 2005 or 2006 when more applications are available. At present, the only likely scale-up use of a 64 bit Itanium 2 platform would be the consolidation of SQL Server Databases that currently run on a separate machine from the applications that use them. This use would require collocation of the applications in the data center on an appropriate scale-up or scale-out platform. Example platforms that might be considered are the Commonwealth's Unisys ClearPath 7802 or the Unisys ES7000.

> ***Servers—Optional Best Practice 4:*** *Virginia should be very cautious in using Intel Itanium processors in any scale-out solutions without addressing 16 bit application use, 32 bit application performance problems, and processor heat problems in dense configurations.*

Across the solutions, Solaris, HPUX and zOS will compete on the high end (Windows Datacenter will not be very competitive in the near term) and Windows, Linux, HPUX and Solaris will be scale-out solution contenders. Example appropriate uses are provided in the table.

Servers— Recommended Requirement 1: *Virginia shall limit OSs in its architecture to zOS, Solaris, HPUX, Linux, Windows and virtualization OSs for all future platform acquisitions.*

Servers—Recommended Requirement 2: *Virginia shall exclude the following operating systems from scale up contention: MPE, MVS OS 390, Unisys OS2200, VMS, AIX and OS/400.*

Servers—Recommended Requirement 3: *Virginia shall consider only Solaris, HPUX, and zOS for near-term scale-up solutions.*

Servers— Recommended Requirement 4: *Virginia shall limit scale-out consolidation platform OS contenders to Windows, Solaris, HPUX, and Linux.*

Servers—Optional Best Practice 5: *Virginia may consider Windows Datacenter for scale-up solutions in the future (e.g., perhaps by 2005). Some considerations are whether the Windows 2003 improved workload management is proven to be effective and whether cost-effective, comparable implementations are identified. For existing 32-bit applications on Windows, scale-out solutions are expected to be more effective for consolidation.*

Servers— Recommended Requirement 5: *Virginia wishes to encourage hardware competition when compatible hardware is an option. When considering hardware alternatives on high-end platforms, Virginia agencies, including higher education administrative units, must require "plug-compatibility" for applications. In most instances, the hardware and OS for a high-end server are acquired as a unit from the same manufacturer. When hardware options are possible, Virginia must take care to ensure that the different hardware alternatives do not introduce variables that would change application resource management strategies, application portability, database portability, etc. The alternative must be in line with Virginia's total planned architecture. Bid requests for consolidation platforms must specify all required elements of management, maintenance, and software systems compatibility.*

Servers—Optional Best Practice 6: *Virginia agencies should consider all high-end platforms in the architecture as potential candidates for any application that requires high-end server performance, availability, scalability, and security.*

High-end Servers—Generally

Most individual applications in the Commonwealth do not require high-end platforms. As a result, high-end platforms will play their greatest role as consolidation platforms. High-end platforms can provide scale-up consolidation solutions, and they will also compete for scale-out business using virtual partitions (e.g., running Linux).

On the high end, architectural simplification is important for controlling costs by leveraging greater platform-specific high-end capacity needs when negotiating maintenance and acquisition prices and also by reducing diversity of expertise and training required.

Past efforts to simplify the high-end architecture have not generally resulted in the elimination of platforms despite reports recommending the changes. This occurs because of

the life cycle of enterprise applications running on the high-end platforms, the fact that it is rarely cost effective to migrate custom-coded applications, and the existence of enterprise needs for continued access to legacy data. Given these obstacles, how will Virginia simplify its architecture? Certainly the recently increased central control of platforms will have some impact on reducing the proliferation of multiple platforms. Central control combined with a sound future simplification vision will assist in limiting additional development on platforms that are not in the future, desired architecture. In addition, centralized planning and procurement will enable more uniform development and use of information related to the cost and benefits of simplification. Central planning will ensure the use of enterprise-wide savings as well as enterprise benefits in alternative comparison decisions and procurements.

Midrange to Low-end Servers–Generally

Midrange to low-end servers will support the majority of applications that remain under agency control in the near term. Most of these applications presently run on Windows, Linux, Solaris and HP-UX. These operating system types will continue to be strategic in Virginia's architecture.

As with servers in the business world, a large proportion of Virginia's Windows servers run older NT operating systems, which are listed as obsolete or transitional in Table 10. Virginia could use virtual servers to support this variety of Windows versions on a single midrange to high-end platform in a scale up solution, or it could group like systems in farms of similar work as it slowly transitions the Windows architecture to fewer versions. The current Windows 2003 Enterprise and Datacenter editions will provide greatly improved clustering abilities. Microsoft's recent acquisition of Connectix virtual server software may result in additional transitional architectural choices.

Virginia will begin to move utilities and applications to more consolidated systems of control as utility services are centralized and more servers are managed centrally. The architectural approach used for consolidation and centralization will depend on the service or function. Both scale up and scale out solutions may be considered for each.

The small midrange and low-end Windows, Linux, Solaris, and HP-UX servers will be important components in the scale-out solutions, whether blade frames or clusters of appliances, bricks, or servers. Virtual server scale outs may be competitive on midrange or high-end soft partitions if the added overhead is not a problem (costs, capacity, and I/O delay).

Numerous manufacturers are competitive for small servers and appliances. Fewer provide solutions that are competitive in the blade arena. Virginia should use standard procurement methods to select a small number (two or three) of manufacturers to compete for server, blade or appliance hardware business for a particular operating system. For farms, clusters, blade frames and utility groupings in a scale-consolidation solution, additional member servers should be acquired by sole source to improve architectural consistency as long as compatible replacements and additions are available.

Linux for Low-end to High-end Servers

The last row of Table 10 provides information on present day strategic uses of Linux for the Commonwealth's executive branch agencies, assuming that the results of the lawsuit between IBM and SCO UNIX will permit continued use of Linux. Currently, Linux servers are not

recommended for hosting mission-critical applications, although this is expected to change fairly rapidly over the next five years. One particular strategic use of Linux systems is Web site serving.

The main promise of Linux in addition to being simple and speedy is that it may be an inexpensive operating system in certain situations. In the IBM world, for example, cost saving would be realized as a result of IBM exempting Linux virtual partitions from the calculation of zOS licensing costs. In the midrange and high-end UNIX world, savings could result from reductions in configuration costs of the more complex UNIX OSs.

> ***Servers—Optional Best Practice 7:*** *At present, the most appropriate opportunities for using Linux in Virginia Government are for Web hosting (e.g., proxy servers, firewalls, etc.) and cache.*

UNIX Platforms for the Midrange and High-end Servers

Each of the high-end UNIX market leaders provides sound hardware and software solutions that will meet Virginia's basic needs. The rationale for choosing two of the three (i.e., HP and Sun) is based mainly on the need for simplification. The track record of the companies and their future directions are important to meeting Virginia's needs. More specifically, the questions for high-end server architecture are: how many platforms are needed for good price competition and how well do the manufacturer's directions for high-end solutions support Virginia's architectural vision. Architectural simplification choices cannot be made based just on the quality of one point-in-time solution, because the manufacturers solutions are always changing. Architectural choices must be based on the manufacturers future vision and its fit with Virginia's envisioned architectural directions. Some of the reasons for the Sun and Hewlett Packard UNIX selections are as follows:

- Sun and HP both provide the sound SMP high-end and scaled-down midrange platform and software solutions most needed for Virginia's business applications and their consolidation
- Sun's high-end Solaris solutions (Solaris on Sun hardware solutions) have made Sun a market leader in both innovation and quality
- Sun's solutions compete with the IBM mainframe
- Sun provides strength in the present Internet architectural phase and competes soundly with Hewlett Packard on all RISC solutions
- Sun's present and future directions in workload management software for scale out consolidations on blade platforms is in line with Virginia's needs
- Hewlett Packard's HPUX on RISC processors and innovation paths to future cost savings on Itanium processors provide Virginia with a competition path that spans Windows and UNIX OSs, and Itanium and RISC processors, thus providing competition across the architecture as this battle heats up
- Hewlett Packard's Utility Data Center management strategy provides adaptive management options that support service level agreements on consolidation platforms through server, storage and network virtualization.

- Hewlett Packard has experience in transitioning MPE to UNIX
- Hewlett Packard's utility computing vision is in line with Virginia's desire to use resource sharing for gaining cost efficiencies.

Together, these two manufacturer solutions meet Virginia's needs, provide the desired competition, and provide future migration paths that are needed.

Servers—Optional Best Practice 8: *Both scale-up and scale-out solutions are strategic options for consolidation in Virginia. Scale up solutions may begin on midrange platforms that can scale to high-end size.*

Servers—Optional Best Practice 9: *Virginia should define platform strategies by workload type.*

Servers—Optional Best Practice 10: *Virginia should leverage its business volume, its central control, and the cost-benefits of simplification in all platform procurement and scaling decisions.*

Servers—Optional Best Practice 11: *Virginia should be cautious in future considerations of Intel scale-up solutions using Windows Datacenter without strong proofs of concept and/or actual implementations of similar magnitude and purpose that demonstrate cost-effective, manageable, high-quality solutions.*

Servers—Optional Best Practice 12: *Virginia should consider server appliances for cache, Web serving, storage, and other simple uses.*

Permitting Exceptions

For the Commonwealth's critical, high-end applications, it may not always be possible to devise a cost-effective alternative involving one of the target platforms. For example, one important consideration may be the use of a particular operating system by another state to support an application that could be easily modified to meet Virginia's needs. The agency may be able to reduce its application development costs substantially by reusing the application, and that application may be proven to work well only on the operating system used in the other state. If, for example, the application were on an IBM AS400 running under the proprietary OS400 operating system, using this system could be less expensive by far than switching to the new architecture. The future architecture will need to be flexible enough to permit exceptions including, for example, use of available capacity on an AS400 system already in existence in the Commonwealth, outsourcing the support of the application, or acquisition of additional capacity for legacy systems that remain in house.

Competition for Transitioning Applications on Obsolete Platforms

Whenever an application is being considered for moving from its native platform, which has been declared to be transitional in Virginia's architecture, to a strategic platform, competition among acceptable strategic platforms must be encouraged. At first glance, there may seem to be only one logical option. For example, Hewlett Packard will eliminate support for its MPE operating system (e.g., HP3000, e-class and k-class servers) in December 2006, and Virginia applications using MPE must be transitioned to new platforms and operating systems. One could argue that HPUX (RISC or Intel) is the logical platform for MPE systems because HP offers hardware and transition assistance price breaks. However, other companies may be

willing to provide excellent transition and future management price breaks too. Virginia must leverage future simplification choices for its whole platform environment when each and every application platform choice is made.

VMS

There is considerable debate about OpenVMS. GartnerGroup has written articles that caution strongly against expanding OpenVMS implementations, but HP insists that it will support OpenVMS and has it scheduled to move from RISC to Itanium (i.e., Itanium III). Virginia has a fairly large investment in VMS, as do sectors of the federal government. Virginia's installed base includes VAX and Alpha servers. In its 2001 paper[51], GartnerGroup lists a number of reasons for being cautious about continuing VMS, including three that are of particular concern for Virginia's agencies. One is the concern about the dwindling supply of staff. In fact, HP's promises of a staffing pool may further erode Virginia's in-house staff given Richmond's proximity to D.C. A second reason is a concern about how well OpenVMS will perform on Intel platforms. A third reason is concern about diminishing third party support and not knowing when a company like Oracle might pull its support for OpenVMS. For these reasons, the enterprise architecture recommends that involved agencies address moving from OpenVMS and VAX VMS in their long-range information technology plans.

> ***Servers—Optional Best Practice 13:*** *Virginia's agencies that presently use OpenVMS and VAX VMS should begin to address transition options in their long-range plans.*

High-End Proprietary Systems

Systems including the AS400 and Unisys 2200 platforms currently support important mission critical business for the Commonwealth. As with VMS, these are excellent systems. However, Virginia must simplify somewhere, and the most proprietary systems with the lowest installed base are easily targeted. For systems such as these, manufacturers are trying to hang on to their "cash-cow" installed base, but will likely discontinue support at some point in the future. Planned movement away from these systems as applications and hardware approach end-of-life status seems a reasonable choice. If Virginia were acquiring mainframe class computers today, it would have a difficult time arguing need except as consolidation platforms. Keeping only the high-end systems with the greatest share of Virginia's applications seems a logical first move in providing a more simplified architecture. There is little evidence to support a choice among high-end platforms based on cost differences. Typically, acquisition bargains and maintenance costs balance out. The zOS, Solaris, and HP-UX platforms win out when compared with Unisys based mainly on the relative proportion of Commonwealth business supported. The Unisys' main future business in Virginia is support for the Mapper database and applications of the Department of Social Services (DSS), for which DSS has not found a cost-effective alternative (e.g., moving the application to a Mapper database on a Solaris System).

Unisys gained popularity rapidly in the early 1980's because designers and programmers were able to more quickly develop applications using Mapper than using Cobol on an IBM.

[51] The Future of OpenVMS, Research Note, December 20, 2001, Strategic Planning, SPA-14-7940, George J. Weiss, GartnerGroup.

Although the DSS has been able to move some Mapper applications to Solaris, doing so with the remaining applications would not be cost-effective at this time. The present hardware and software on the Unisys has an end-of-contract date of April 2007.

Summary of Anticipated Architectural Changes

Over time, the target server architecture changes in Virginia will result in:

- Fewer servers
- Fewer locations
- Better service with fewer staff (e.g., for backup provision)
- More high density solutions
- Increased reliance on telecommunications
- Movement of databases to separate platforms or to separate partitions on the same platform
- Fewer operating systems
- Increased use of scale-up and scale-out consolidation solutions
- Scalable server solutions for utilities including email, web page serving, and storage
- Use of virtual servers for development and some testing
- Use of virtual servers for accommodating multiple versions of an OS as a transition strategy for consolidation of a network function
- Use of appliances for functions including cache, storage, etc.
- Use of stored images for rapid provisioning changes to clusters
- Active consideration of "within-architecture" platform alternatives for all new and revised business applications
- Tracking of staffing requirement issues related to each operating system supported
- Tracking data on architectural patterns by application
- Tracking of planned retirement dates for applications and for server hardware
- Increasing use of Linux
- Managed increases in uses of Solaris and HPUX
- Decreasing use of Windows where Linux is used
- Managed decrease in the use of all platforms not in the architecture
- Managed increase in use of platforms in the strategic architecture
- Eventual use of Windows as a consolidation platform
- Continued use of commoditized hardware at the low and low-midrange server end
- More consistent product life-cycle management

- Continued acquisition of high-end platform capacity when it is needed (e.g., for processor activation, processor acquisition, etc.)
- Having lease lengths that match anticipated technology life
- Movement to consolidation platforms only if cost effective (effectiveness assessments include consideration of the value of all benefits such as security, customer service improvements, and other consolidation benefits)
- Consideration of platform outsourcing if all applications remaining on an "out-of – architecture" platform custom-coded applications with low availability or use needs.

Additional Recommendations for All Servers

The following recommendations are offered in addition to those provided above for server architecture. These apply to all server solutions.

Servers—Recommended Requirement 6: *Servers in the Commonwealth that provide local area network services (e.g., domain control), file services or print services must use the same operating system to facilitate central management and central consolidation opportunities. The Enterprise Architecture establishes Windows 2000, Windows 2000 Advanced Server and Windows 2003 as the target architecture standard for these servers. This standard shall remain in effect if appropriate central management systems and consolidation options are available, and if cost effectiveness is confirmed by a Virginia study of alternatives and price negotiation results.*

Servers—Recommended Requirement 7: *VITA shall examine the feasibility, costs, and benefits of standardizing on Exchange as an Email Server. The study shall consider whether centralizing email is cost effective and whether standardizing on Microsoft Exchange or another enterprise solutions is cost effective. With network services standardized across agencies, opportunities for providing central utilities improve. Resource directories including those related to email may be centrally controlled and locally managed.*

Servers—Recommended Requirement 8: *Individual agencies, including higher education administrative units, and VITA shall ensure that servers are under a maintenance agreement for the planned life of the server.*

Servers—Recommended Requirement 9: *Individual agencies, including higher education administrative units, and VITA shall examine consolidated storage alternatives whenever considering acquisitions of file servers.*

Servers— Recommended Requirement 10: *To promote cost-effective reuse of applications developed for other states and for governments generally, the Enterprise Architecture shall permit consideration of platforms not in the desired architecture. A specific OS may be part of the only proven implementation for selected reusable business applications, and the flexibility to choose proven solutions must be permitted. Exceptions should be provided to all agencies when warranted including higher education administrative units.*

Servers— Optional Best Practice 14: *Virginia should track data on staffing, staff retirement plans, staff skills and staff retraining interests.*

Servers— Optional Best Practice 15: *Virginia should track data on hardware and software retirement plans.*

Servers— Optional Best Practice 16: *Virginia should first define its consolidation options for non-file-service storage (i.e., block services storage) and then define consolidation platform management services, email consolidation, file/print services consolidation, and web hosting services consolidation.*

Servers—Optional Best Practice 17: *When conducting cost-benefit analyses for an application, individual agencies or central services should consider full costs of server alternatives and not just up-front costs.*

Servers—Optional Best Practice18: *Individual agencies and VITA should consider the agency's goals, the Commonwealth's goals, and Enterprise Architecture guidance when selecting server solutions.*

Servers—Optional Best Practice19: *Individual agencies and VITA should employ manufacturer-specific systems setup policies and best practices.*

Servers—Optional Best Practice 20: *Individual agencies and VITA should ensure that the maintenance support response-time is in line with business needs for applications on each specific server.*

Servers—Optional Best Practice 21: *When an agency employs a different server solution in an otherwise homogeneous shop, the agency should consider supporting the different server by using in-sourcing (i.e., contracting with another agency or with VITA) or outsourcing alternatives.*

Servers—Optional Best Practice 22: *The Commonwealth should evaluate Linux for Web serving. Linux is opportune because of anticipated cost savings and because it is being explored worldwide as an alternative to Windows for selected lower-risk uses. Linux may be used on individual midrange to low-end servers or may be managed as a virtual server on a high-end system.*

Servers—Optional Best Practice 23: *If the Commonwealth requires use of Windows 2000 (or higher) as the operating system of choice for all domain control functions, the Commonwealth should implement a centrally controlled forest structure across all executive branch agencies. A forest (also known as an enterprise) is a collection of domains and domain trees.*

Technical Topic #3: Storage

The term storage is used here to mean the hardware, software, communications, and management systems required to record data somewhere other than in memory (e.g., RAM) and to index the data in a manner that allows it to be retrieved at a later time.

Historically, the systems that were used provided:

- Internal server storage (e.g., server hard disk/RAID), or

- External server storage, which is also called direct attached storage or DAS (e.g., SCSI connection to RAID disk or tape system).

The storage might have been managed by file management software, database management software, or perhaps backup and recovery software. Chances are that every application had its own separate storage solution.

Today's solutions include the historic solutions and more complex, enterprise storage models. The solutions also have many more management options including centralized management regardless of geography. Options include a variety of different access channels and storage media (e.g., tape, disk, CD, DVD[52]). These solutions sometimes use the existing LAN or WAN and sometimes use dedicated paths and/or separate storage networks for moving the data. Also, many different protocols and interfaces (e.g., Ethernet, FC, ESCON, FC-AL, iSCSI (IP), SCSI) may be used in the transmission of stored information from the source to the storage medium.

Storage planning requires looking at storage needs from a variety of perspectives. Planners must consider the current and future storage needs for applications and services (e.g., email), legal requirements, agency policies, and executive branch service improvement opportunities (e.g., opportunities to provide a cost-effective central utility for executive branch agencies). Every agency, small or large, needs to consider the following.

- Special needs of each application or service
- Current handling of storage
- Performance requirements
- Data from periodic assessments of whether planned storage capacity meets expected future storage needs
- Whether backup and disaster recovery systems are adequate
- Whether storage management systems are meeting business needs
- How well storage traffic is being handled by the networks or other connections used in transmitting data (e.g., local area networks (LANs), SCSI connections, wide area services (WANs) or special storage networks (SANs))

Although storage needs must be assessed at the application and service level, solutions should be designed at the agency or enterprise level. An agency focus would address agency network performance, application performance, user services, and data back up and disaster recovery needs.

Storage planners who are considering options to meet storage needs at the executive branch level must view storage as a utility for applications or services. Example utility solutions include the following.

- Centralizing or regionalizing selected services with escalating storage needs such as email services to take advantage of storage models and management solutions that

[52] For a good discussion of RAID and CD solutions, see http://www.mosaic-sys.co.uk/html/nf100_qa.html#2. For a discussion of tape issues and tape roadmaps see http://it-div-ds.web.cern.ch/it-div-ds/HO/pasta_tape02.html.

may be too costly for most agencies and to provide leverage for price/license negotiations

- Gathering capacity planning and trend data from agencies to provide a basis for considering central options
- Ensuring that storage planning is done across all agencies for any servers/applications that are centralized via consolidation efforts or managed centrally at the request of agencies
- Providing backup and recovery services as a utility

The more complex storage models are SANs (storage area networks), NAS (network attached storage) or mixed models (SAN/NAS combinations). In theory, SAN and NAS storage solutions may be designed to improve the management, efficiency, scalability, flexibility, and availability of storage resources across an agency or an enterprise.

In addition to having a variety of storage models to choose from, agencies and central planners also have choices of new interfaces and transmission protocols, storage management solutions, and media options. Also, agencies will have new options such as the still evolving iSCSI protocol solution, which transmits the data to be stored via IP packets.

Storage is a simple need, but the solutions range considerably in complexity, cost, and automation. The first order of business is to try to provide a picture of the range in storage models, media, managers, and model hardware components without providing an overwhelming amount of technical detail.

Storage Services Overview

The first defining factor for storage models is that storage requests are of two types, block services requests and file services requests. Personal computer clients on a network usually request files—document files. Web clients usually request files—web page files. Large database servers, email servers, and other applications, on the other hand, usually deal in blocks of data. File server and NAS solutions provide file services and rely on a local area network (LAN) when interacting with the applications requesting storage. DAS and SAN solutions usually provide block services that do not use the LAN but instead use a separate storage connection and transit medium. Examples of combinations that provide block services are Fibre Channel (FC) SANs and SCSI DAS.

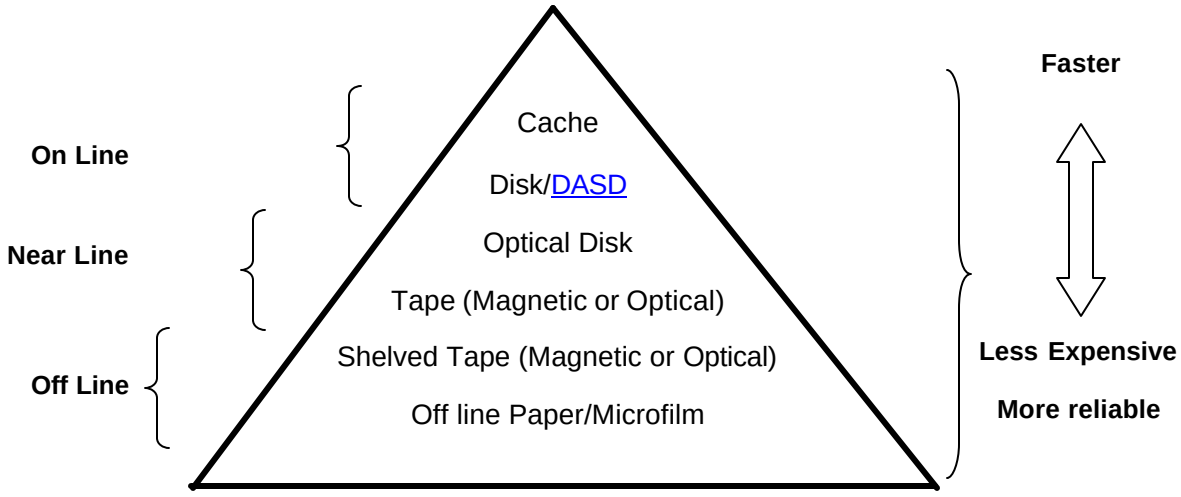
Mixed models may try to provide both files and blocks to the requesting applications. A NAS Gateway is one term that may be used for a mixed solution broker. The mixed model may have NAS, SAN, and DAS components.

On the destination end of a storage solution are the actual storage systems (media and controllers). These may be disks, tapes and other media for storage with internal and external management utilities and control systems (e.g., tape library management software or enterprise storage management software).

Storage media are often described in a hierarchy that is based on relative accessibility, reliability and cost. In the past, cost differences across the hierarchy were enormous. Now the differences have decreased considerably.

Figure 5 provides one view of a storage hierarchy. The accessibility, cost and reliability dimensions portrayed in Figure 5 are not hard and fast. These qualities depend on the total solution design including the interface, the network/bus, the controllers, the management software, and the transmission protocol used to access data stored on the medium.

Figure 5: Storage Media Hierarchy



The management systems that control media access and other functions have varying capabilities for supporting important business needs including backup, recovery, and redundancy, for example. The management features of a storage system can reside in the storage server's operating system, a switch, the medium itself, or in separate software that manages part or all of the storage needs for an enterprise. Table 11 below summarizes some of the storage control features that might be available through a solution's media controller. Table 13 provides examples of specialized services that are available in high-end bundled solutions, mainframe storage management modules, or add-on third party enterprise storage management software.

Table 11: Built-in Storage Management Services

Storage Type	Media Controller	Possible Media Controller Services
Cache	Server OS, Business Application	Access speed improvement
Disks (Arrays, Optical, DASD)	Built-in Management Software for Disk Array Controller or Disk Tower	RAID protection levels 1-5; multi-pathing with path failover; synchronous and asynchronous mirroring; data warehouse input
Tape (Magnetic or Optical)	Built-in Management Software for Tape Drive, Library, or Autoloader	Automated backup and restore; 24x7 automated library access; auto inventory

Table 12: Examples of Special Services Provided through Mainframe Storage Modules or Third Party Storage Management Software

Example Storage Services[53]
Hierarchical storage management solutions (i.e., moving infrequently used data to cheaper, less available media)
Automation of storage services by application (for provisioning, resource management, back up and recovery, and the archiving of data)
Snapshot, replicate, and archive services
Policy-based control for the entire storage environment (including archiving to read-only media for legal reasons)
Separation of email from attachments for improved email archiving solutions
Aids for establishing recovery priorities
Aids for sharing tape hardware and software across a variety of heterogeneous disk systems (e.g., backup for a multi-vendor SAN)
Aids for managing backup, recovery, restore across an entire distributed storage system
Enablers of multi-pathing and path failover

File servers, SANs, NAS, DAS and Mixed Storage Models

The following discussion will provide a simplified view of DAS, NAS, SAN and file server solutions. The discussion borrows heavily from Robert Strechay's[54] August 2000 explanations of DAS, SAN, and NAS options, the Storage Network Industry Association's (SNIA's) white paper[55], and a technology overview provided by GartnerGroup[56]. Mr. Strechay provides simplified diagrams to show where storage resides in relationship to servers and clients that use the storage and the LAN where the servers and clients reside. These diagrams are reproduced in Figure 6 below.

SANs are highly scalable, fast, storage solutions that can accommodate metro area distances. They are relatively expensive and difficult to install and manage. The SAN controller is the switch. Strechay's SAN diagram (his Figure 1) shows a LAN on the left, a SAN on the right. The SAN includes the connection to the database or application server, the switch, and the storage. The pictured database server is dually connected to its LAN customers (servers and

[53] Taking the tedious out of storage management: New-style automated hierarchical storage management products add more smarts to managing aging data. By Deni Connor, Network World, 09/09/02. http://www.nwfusion.com/supp/storage2002/arch.html

[54] Why Should You Care About SANs? from the August 2000 issue of Business Communications Review, pp. 38–42by Rob Strechay, http://www.bcr.com/bcrmag/2000/08/p38.asp.

[55] Shared Storage Model, A framework for describing storage architectures, June 5, 2001, Storage Network Industry Association.

[56] NAS vs. SAN: Technology Overview, November 13, 2002. Nick Allen, Pushan Rinnen, and April Adams. DPRO-97417.

clients) and to the SAN where it stores data. Other servers on the LAN could also use the same SAN switch for their storage needs. To do this, they too would have a dual connection to the SAN switch and the LAN.

The separate SAN network and usually, the SAN fabric switch are defining elements of the SAN model. The switch could use any of a variety of protocols to communicate with the attached servers and storage including FC-AL, iSCSI (IP packet switch), FC-IP, or even E-SAN (Ethernet switch) in addition to the protocols Strechay has listed in his diagram.

Strechay's second diagram shows a simplified NAS model. The defining characteristic here is that a server or client on the LAN can access the NAS storage directly through the LAN. Strechay shows the storage and the NAS server that controls the storage as a unit. Thinking of them as separate elements may help in understanding the mixed models. In this model, the NAS server (also called a NAS engine, a NAS head, or a NAS gateway) is attached to the LAN directly and the NAS server is the default controller for the storage.

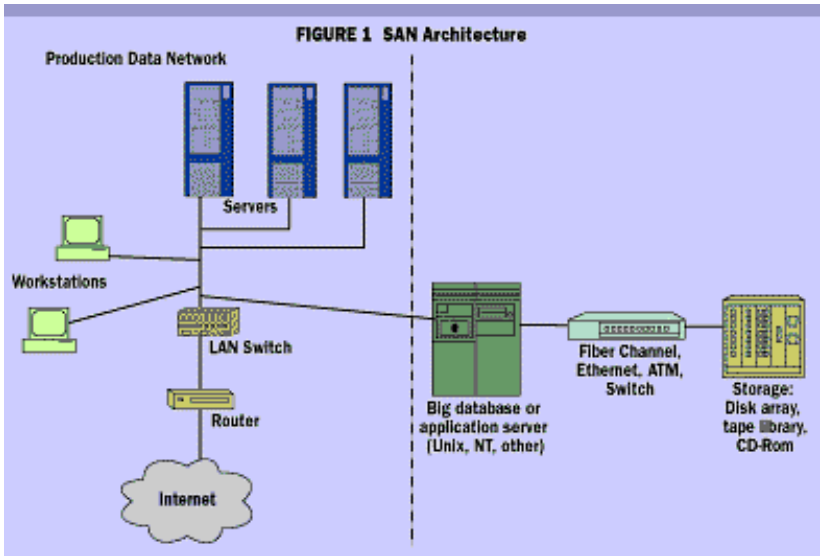
The NAS solution is easily set up and managed by network-savvy personnel, but NAS is not as scalable as a SAN. Some companies provide modified NAS solutions that enable block services and faster data transfer.[57] In many ways, NAS is just a file server honed for storage management functions. NAS servers can serve multiple file protocols including NFS, SMB, CIFS, HTTP, and FTP. NAS can also enable multiple accesses and updates to the files it controls. NAS usually replaces file servers when implemented.

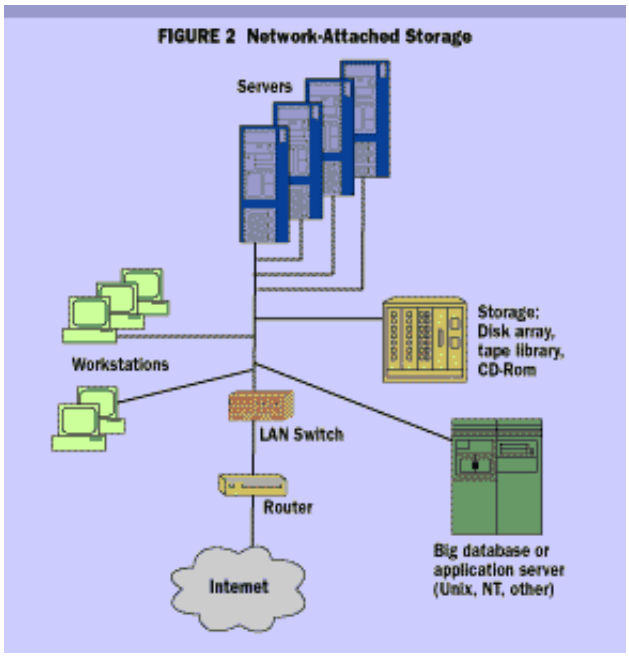
Strechay's final diagram shows DAS. DAS looks similar to a SAN. In many ways, the SAN model builds on the strengths of DAS. DAS directly connects storage to a server through dedicated connections. The connecting medium is also dedicated and not part of the LAN. One typical DAS solution uses a SCSI interface. The default controller for DAS storage is the operating system of the server. The storage itself may also have some controller capabilities.

Modern DAS options from companies with the greatest market share are highly scalable and fast. Mainframe DAS is in a class by itself, offering a very high level of scalability and manageability.

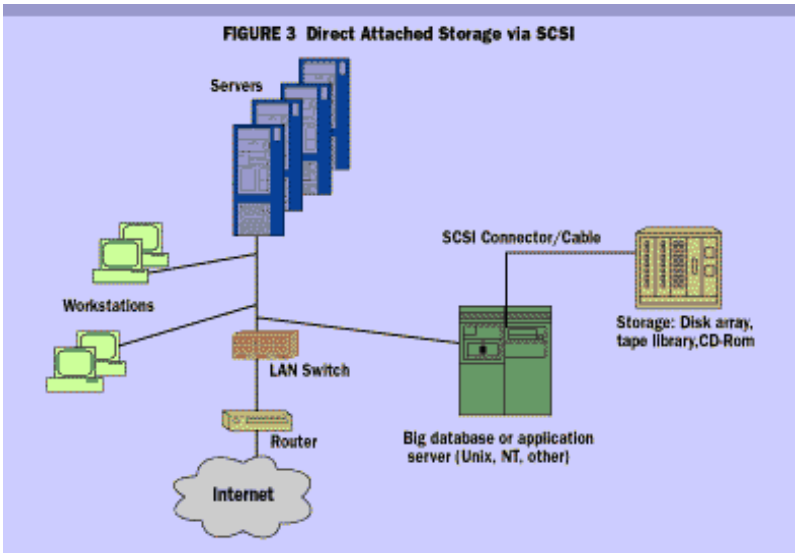
[57] using DAFP—Direct Access File Protocol

Figure 6: Strechay's SAN, NAS and DAS Diagrams[58]





[58] Why Should You Care About SANs? from the August 2000 issue of Business Communications Review, pp. 38–42by Rob Strechay, http://www.bcr.com/bcrmag/2000/08/p38.asp.



In general, an enterprise can greatly improve its storage management by installing a third-party enterprise storage management solution. The management software may be layered on top of the various storage models used across an enterprise.

What Strechay's diagrams do not attempt to show is that these models can be mixed further. For example, the NAS file server could be connected to a SAN fabric switch to enable both file and block services. Also, NAS server-controlled storage could be an option on the back end of a SAN along with directly controlled disk, tape, CDs and DVDs. Several companies now offer mixed NAS and SAN equipment. Table 13 below provides a more detailed explanation of the separate SAN, NAS, and DAS models.

Table 13: DAS, NAS, and SAN

Storage Type	Definition
Direct Attached Storage (DAS)	DAS is a storage model that involves a physical connection between a server and a storage resource. DAS is easy to implement compared to NAS and SAN. The storage system that is directly attached to the server is usually an array of disks but could also be a tape subsystem or other resource. Some call DAS disk array solutions a "SAN in a Can," because the disk provides its own controller. In most DAS implementations, the server is a single point of failure. This is an issue with small servers but not with mainframes, which are more robust.

Storage Type	Definition
Storage Area Network (SAN)	A SAN is a high-speed special-purpose network (or subnetwork) that interconnects different kinds of data storage devices with their associated data servers. Typically, a SAN is part of the overall network of computing resources for an enterprise. A SAN is usually in close proximity to other computing resources but may also extend to remote locations for backup and archival storage, using wide area network carrier technologies such as asynchronous transfer mode (ATM) or Synchronous Optical Networks (SONET). A SAN may use communication technology such as IBM's optical fiber ESCON or Fibre Channel technology. Some SAN system integrators liken the SAN to the common storage bus (flow of data) in a personal computer that is shared by different kinds of storage devices such as a hard disk or a CD-ROM player. SANs can incorporate sub-networks with NAS systems. This definition is modified from WhatIs.com
Network Attached Storage (NAS)	Network-attached storage (NAS) is often disk storage that is set up with its own network address rather than being attached to an application or database server. By removing storage access and its management from the server, the server can run applications or perform functions faster because these uses are not competing for the processor resources with the storage and retrieval functions. The NAS file server and storage are attached to a local area network (typically, an Ethernet network) and assigned an IP address. The main network server maps file requests to the NAS file server. Network-attached storage usually consists of hard disk storage, including ATA disks and multi-disk RAID systems. NAS also has software for configuring and mapping file locations to the network-attached device. Network-attached storage can be included as part of a SAN. Network support personnel often have the right mix of skills to successfully implement and manage a NAS system. NAS systems are like file servers with pared down operating systems and beefed up storage management features. NAS software can usually handle a number of network file protocols. Configuration, including the setting of user access priorities, is usually possible to do using a Web browser. This definition is modified from WhatIs.com

Why Consider Storage Alternatives?

So why talk about storage models? The answer is that storage is becoming a problem for some agencies and some business functions such as email. The following are some indicators of problems, which may be helped by implementing a new model or checking out storage management software for the model in place.

- Storage needs are growing by leaps and bounds and storage is the main reason the agency is buying new servers.

- The agency is trying to manually back up dozens of separate storage units.
- As storage grows, planning and management of backup and recovery becomes too complex.
- Storage traffic is interfering with LAN traffic.
- The window of opportunity for completing backups has become too narrow.
- The agency needs greater control of storage for security reasons or legal requirements.
- The state is centralizing services such as email and needs greater control over storage such as hierarchical storage management or policy driven storage management.
- Various server and service consolidation efforts require simultaneous consideration of storage handling options.

Across agencies, the predicted increase in server acquisitions to accommodate growing storage requirements may offer a particularly compelling reason to consider storage alternatives. Meta Group predicts that 70 to 80 percent of servers acquired in the next two years will be for storage. Although costs of hardware are declining, the escalation in need makes server acquisitions for storage a growing IT budget item for which volume can be leveraged in negotiating prices.

Modern storage solutions provide opportunities to do the following.

- Centrally manage and control storage
- Manage storage by applications or servers
- Enable storage management staff to handle up to four times as much storage with no increases in staff
- Move storage access off the LAN, thus reducing LAN traffic
- Improve backup and disaster recovery options
- Provide automation of long term storage options and
- Enhance security controls for data (e.g., through improved systems design)

A SAN or NAS model may offer significant opportunities for controlling storage costs, but the return on investment may take time. Also, changing from DAS to NAS or from DAS/NAS to SAN solutions is not always cost effective. The agency's present architecture, problems they are experiencing, and future storage needs are important factors in deciding whether more complex storage solutions than DAS and file servers are a good idea.

No agency or business can consider changes in how storage is handled without first conducting capacity planning. Agencies must have a handle on present and future needs for storage and for network traffic before they can discuss options.

> ***Storage—Recommended Requirement 1:*** *VITA shall require that agencies provide periodic capacity planning and storage planning data. The availability of planning data will improve agency and central storage solutions and backup and disaster recovery solutions.*

Storage—Optional Best Practice 1: *VITA and any other agencies, including administrative units of higher education agencies that provide platform services should consider all platforms under their control when conducting capacity planning and when developing a storage plan. For consolidated servers or data-center resident applications, the managing agency should examine storage needs at the application level but design storage solutions at the data center level.*

Storage—Recommended Requirement 2: *VITA staff shall use information from agency capacity and storage planning to investigate the feasibility of providing central storage utility services.*

Virginia's "As Is" Architecture for Storage

Commonwealth agencies mainly use file servers and DAS for storage. Table 14 provides counts of agencies that reported shared devices[59] related to storage solutions. These agencies are the larger agencies. Of SAN and NAS solutions, SANs are the least deployed.

Tape silos, tape subsystems, and CD towers can be part of SAN, NAS, or DAS solutions and can be dedicated or shared across applications and clients. Table 15 provides information on agency use of these systems.

Table 14: Executive Branch Agencies Excluding Higher Education Reporting SAN or NAS systems

Storage Components	Count of Owner Agencies
Network Attached Storage	12
Storage Area Network	7

Table 15: Executive Branch Agencies Excluding Higher Education Reporting Tape and CD systems

Storage Components	Count of Owner Agencies
CD Towers	18
Tape Cartridge Subsystem	20
Tape Backup Silo	12

In the Commonwealth's data center, storage solutions are typically designed and acquired to meet the needs of each centrally managed application separately. Web server storage is planned across all users. Mainframe computer storage is planned at the agency level and solutions are designed across all agencies.

[59] VA Due Diligence data, FY 2002. Reports from 94 Executive branch agencies.

Commonwealth's Goals for a Storage Architecture

The Commonwealth's vision for storage is to have agency and central storage systems that are well planned, appropriately implemented and well managed. By conducting capacity planning and identifying agency-wide storage needs, an agency will be able to select among the storage alternatives available. The following are example agency and Commonwealth goals for improving storage systems.

- Increase storage reliability (e.g., address data availability and redundancy).
- Improve storage scalability (e.g., implement a solution that will overcome present software and solution limits).
- Improve service levels (e.g., improve response time and speed).
- Lower storage costs (e.g., use a greater percentage of available capacity, implement systems that can be managed with fewer human resources).
- Reduce the need for planned outages (e.g., enable hot-swapping, remove storage traffic from the LAN).
- Improve backup systems or disaster recovery (e.g., by centrally managing functions using software capabilities within an agency or multi-agency services).
- Improve file-serving speed (NAS).
- Improve block-servicing speeds.
- Decrease I/O burden on hosts.
- Improve network availability (e.g., create a separate storage infrastructure (SAN)).
- Meet write-once, read many times (WORM) media needs of some legal documents (e.g., CDs may be a good option for meeting these needs).
- Accommodate distance requirements.
- Reuse skills of existing staff in providing systems improvements (e.g., NAS models can be implemented with existing network staff).
- Reduce management time.
- Take advantage of management capabilities of more advanced systems and software (e.g., storage management software may provide environment management, virtual storage, metrics, off-site tape tracking, etc.).
- Take advantage of automation opportunities (e.g., server-less backup, business continuation volumes, data warehouse input, synchronous or asynchronous mirroring, snap shot, etc.).

Issues/Challenges

The Commonwealth and its agencies may encounter a number of challenges when trying to design and implement new storage solutions such as SAN and NAS models. Issues and challenges include the following general and solution-specific challenges.

General Issues and Challenges

- Comparing storage alternatives is difficult because the comparisons do not involve "apples to apples" when SAN, NAS, DAS, and mixed models are involved. Meta Group recommends using simple high-level categories for solution costs to provide a basis for comparison as follows.
    - Storage hardware costs (price per GB)
    - Storage software costs (36 mo software total costs)
    - Storage networking components (price per port/total costs per port)
    - Maintenance (costs as a percentage of hardware (if any) and software list price or purchase price
    - Professional services (fee for a statement of work)
- Agencies need to ensure migration paths for file systems currently in use (e.g., for reading old tapes, exchanging data, etc.)

Solution Specific Challenges

Some solution-specific issues are noted below.

- SANs are more difficult to design, implement and maintain.
- Manufacturer interoperability can be a problem with SANs. It is important to require that manufacturers who are cooperating to produce a solution demonstrate interoperability for the product mix. (SNIA[60] and others have tested many multi-company solutions).
- iSCSI standards, which are in the process of being adopted, will increase the use of existing IP networks (LANs, WANs, campus networks, Ethernet MANs, or the Internet) as virtual SANs. This approach is more likely to flourish as 10Gb Ethernet is implemented (thus providing bandwidth that competes with Fibre Channel). iSCSI has considerable potential for decreasing the costs of SAN connections. The challenge is trying to design SANs to cost-effectively meet current needs with expansions solutions that will enable taking advantage of future iSCSI capabilities.

Technology Component Trends

Table 16 below presents storage technology components that are changing and rates them as obsolescent, transitional, strategic, or emerging.

[60] The Next Step: Phase 2 in Multivendor Open SAN Supported Solutions, March 26, 2002, Storage Network Industry Association.

Table 16: Technology Use Trends for Shared Storage[61]

Obsolescent	Transitional	Strategic	Emerging
	Interfaces Block/Parallel (distance limits and speed problems) 4.5 Mbps (Mainframe) ESCON, 17 Mbps (Mainframe) 10/100 Ethernet	**Interfaces** FIBRE Channel -FC, FC-AL (fiber channel arbitrated loop) FICON SCSI 10/100/Gb Ethernet 10/100/2Gb Ethernet	**Interfaces** iSCSI (standard for IP wrapped SCSI is in the final stages of the standards approval process; security concerns)[62] InfiniBand (IB)[63] PCI Express FC-IP 10GigE
		Controllers SAN Fabric Switch NAS Controller (simplified OS) DAS (attached server's OS) DAS Controller Network File Server OS NAS Gateway to SAN Add-on Storage Management Software	**Controllers** SAN/NAS unified controller (hardware/soft-ware combination)
Disk Storage Hardware SLEDS (single large expensive disks once used by all mainframe computers for storage)		**Disk Storage Hardware** External Controller-based RAID ATA Disks Disks CDs	**Disk Storage Hardware** DVD (awaiting write standards)

[61] Requirements in this table apply to executive branch agencies, including the administrative units of higher education.

[62] See Network World, http://www.nwfusion.com/news/2003/0127iscsi.html , IP Storage Standard Set to Roll, 1-27-2003.

[63] InfiniBand is a high-speed, bi-directional, serial computer bus, intended for both internal and external connections. The future of this technology is uncertain.

Obsolescent	Transitional	Strategic	Emerging
Tape Technology	**Tape Technology**	**Tape Technology**	**Tape Technology**
9 track	36 track	LTO (linear tape open)	Terabyte tapes
18 track	DLT (digital linear tape)	SDLT (super digital linear tape)	
	AIT (advanced intelligent tape)	Virtual Tape (Disk)	
		Magstar (IBM 3590; STK 9x40)	

Storage models have several component hardware and software parts that support the physical connections between the storage user and the storage device, the communications and transmissions, and the setup and monitoring of systems and services. The components involve several technologies, some of which have been changing considerably in recent years. Example components and their purposes are provided below.

- Interfaces

  The interfaces connect the hardware on the requesting end with the hardware on the receiving end, typically by attaching to a physical network. The interfaces determine the method and format of the communication so that both ends are speaking the same language. This also determines whether files or blocks are transmitted. The server's OS determines the type of file format supported for a file server, whereas with a NAS server, multiple file types (e.g., NFS and CIFS) would be supported. Example interfaces are FC, ATA, SCSI, iSCSI, FCIP, and Ethernet. iSCSI, when adopted, will permit a SAN to use LANs, WANs and the Internet as transmission vehicles.

- Transmission medium

  The transition medium is usually a fiber or copper wire physical connection for communications among components of the storage system and servers that use it.

- Controllers

  The controllers for the storage system may include a variety of hardware and software components. Simple systems rely on simple controllers built into operating systems or storage media. In more complex systems, which manage large amounts of storage, there are several points of control. Often, highly capable management software coordinates across the many components. Example controllers are a RAID controller, a server OS, a NAS engine, a NAS Gateway, a SAN-attached database server, a SAN Fabric Switch, and storage management software. Adequate remote management and control is an important issue for storage systems.

- A variety of media and media systems

  The media and media systems store the data. Examples are redundant arrays of independent disks (RAID), just a bunch of disks (JBODs), NAS appliances, magnetic and optical tape cartridges/systems, CD towers, tape silos, and tape library systems.

- Canned systems or bundled solutions.

Canned systems provide end-to-end solutions targeted to a specific market. One example is the Prostore Backup Appliance—a plug-and-play ATA-based NAS backup system with an 8-cartridge digital linear tape autoloader system and backup and recovery software, all of which can be managed remotely.

Of the above technologies (see boldface type), the ones with a significant change history or anticipated future advances are provided in Table 16 along with ratings indicated by the column. This table shows that SAN, NAS, DAS, and traditional file servers are all acceptable models for the storage for Commonwealth agencies.

Applicability of Storage System Solutions

Many factors come into play in choosing among storage solutions: present storage needs, anticipated storage growth, server locations, user locations, transmission needs, specialized service needs, and more. In Virginia, storage planning also requires joint consideration of aggregate needs and Commonwealth-wide opportunities for improving services or reducing service costs by meeting needs with central solutions.

Data types are also a consideration in storage planning. Some of the major types of stored data in state government are: agency business application data (e.g., tax returns), central application data (e.g. CARS, DHRM, eVA), utility applications (e.g., email and attachments), application cache, web pages, databases, user-generated files, and user-accumulated research (e.g., saved Internet reports). Specialized agencies such as state, local, and school libraries have additional types including locally managed reference libraries, online books, and journals.

In agencies, one major contributor to the growth of storage is the failure to delete data that is no longer needed. Although the Library of Virginia provides regulations and guidance pertaining to record keeping, this guidance is not used systematically by all agencies to delete unneeded information from computer stores. Keeping unneeded information can have risks and liabilities associated with it. For example, if you have 15 years of email and if a court or a Freedom of Information Act (FOIA) request requires that you produce all email pertaining to a particular topic, you must search the entire 15 years accumulation if you have it.

Modern storage management software permits policy-driven archiving. This type of mechanism provides interesting possibilities for reducing storage systematically. For example, if all email systems were centrally controlled, it might be possible to set a policy to delete all email and attachments after 5 years except for email of agency heads, acting heads, and others whose historically significant communications should be retained permanently.

For both agency- and centrally-managed solutions, the following generalizations are offered. Without a central storage option, small agencies with modest storage needs should continue to use file servers and occasional SCSI attached DAS to meet their needs. Canned NAS systems may be of considerable use to these agencies or to a centrally offered and managed storage service that is locally provided.

Medium agencies with high storage volumes, mixed application servers (e.g., UNIX and Windows), or a need to share files across a mixed environment should consider NAS. These agencies may effectively use a combination of DAS and NAS in their environment or may propose NAS only environments. Agencies with large web-hosting applications requiring

cache, large volumes of email, or databases that are accessed frequently may also benefit from NAS and NAS/DAS combined solutions.

Only the agencies with very large databases, many data producing applications, many employees, and/or over-committed network resources will need to entertain the installation of SANs or unified NAS/SAN options. Agencies that are able to make good use of harder-to-implement SAN solutions will probably have very large volumes of data transmitted in a highly unified environment (e.g., all Microsoft). Agencies of any size that have already met their needs with DAS solutions will likely continue with this model until performance and affordability become issues.

Storage consolidations that provide one solution for multiple agencies may be cost effective in several instances. Possibilities include storage for servers that are centrally managed; applications that are co-located, utility services that are centralized (e.g., email), or servers that are physically consolidated. In these instances, storage capacity planning would be done at the application/agency level and aggregated to the service group level (e.g., agency group, application group or server group).

Additional Recommendations

The following recommendations are provided for considering new storage solutions:

Storage—Recommended Requirement 3: *To reduce escalating storage costs, VITA shall consider storage consolidation opportunities when considering utility services for central handling. Potential utility services that would have large storage needs and/or growing storage needs are email services and Web hosting services.*

Storage—Recommended Requirement 4: *VITA shall explore opportunities to provide cost-effective, centrally managed storage services that can meet the needs of small and medium applications across agencies.*

At present, it is generally cost-prohibitive to attach servers of small applications to a SAN. As iSCSI becomes a recognized standard and iSCSI storage becomes more readily available, the use of this protocol will drastically reduce connection costs and increase the likelihood of having central storage for the application servers of all agencies. iSCSI allows the substitution of inexpensive devices (e.g., Ethernet devices) for expensive Fibre Channel devices and the transmission of storage traffic over existing local and wide-area networks. What this means to storage planning is that one solution may meet a broader range of needs in a cost-effective manner.

Storage-Recommended Requirement 5: *Whenever remote consolidated storage options are cost-prohibitive, VITA and other agencies that manage storage must evaluate the cost-effectiveness of local consolidated storage options for the physically collocated servers under their control.*

Storage—Optional Best Practice 2: *Individual agencies that control storage, including administrative units of higher education and central storage planners (e.g., VITA), should consider a variety of storage alternatives. NAS, SAN, DAS, file servers, NAS/SAN combinations, and in/outsourced services may all be*

appropriate depending on storage volumes, LAN bandwidths, connectivity to central services, and other factors.

Storage-Recommended Requirement 6: *VITA must offer capacity planning and storage planning services to assist agencies in determining their future requirements.*

General Recommendations for Platform Architecture

Some best practices apply across platforms. Recommendations not noted in the sections above are provided below.

Platforms Generally—Recommended Requirement 1: *VITA shall consider business security requirements up front when making decisions for all platforms from personal computing devices to enterprise servers.*

Platforms Generally—Recommended Requirement 2: *VITA shall design systems with interchangeable components to support field servicing of hardware and software.*

Platforms Generally—Recommended Requirement 3: *VITA shall design platforms for remote administration, diagnosis, and systems management.*

Platforms Generally—Recommended Requirement 4: *VITA shall centralize acquisition controls for all platforms acquired in large volumes across executive branch agencies to leverage procurements, improve interagency homogeneity, and provide equitable refresh plans within dollars allocated.*

Platforms Generally—Recommended Requirement 5: *VITA shall deploy a central lab for use in: 1) testing emerging platform technologies and their general applicability to the Commonwealth's computing architecture; 2) partnering with individual Commonwealth entities to provide a focused approach for matching technology solutions with identified business needs; and 3) communicating results to stakeholders.*

(This page is blank, intentionally.)

Summary of Existing Policies, Standards and Guidelines Related to Platform Architecture

ITRM policies are high-level requirements for agencies. An example would be a requirement that all agencies have a security policy. ITRM standards are generally more specific requirements for agencies, such as a requirement to use standards-based cabling in buildings. Guidelines have the status of advice based on research and identified best practices.

The domain team reviewed legal requirements (i.e., laws), regulations, Governor's Executive Orders and existing ITRM policies, standards guidelines to determine what existing guidance should be considered when developing a framework for presenting the recommendations of the ITIB in official ITRM documents. The results of this review are summarized below. The domain team's recommendations may suggest modifying existing laws or ITRM requirements or may simply post them here for information purposes.

Existing Policies

The following existing ITRM policies and laws are related to platforms.

***Existing Policy 1--Technology and Related Procurement Laws*:** *Laws provide for sole source procurements, central control over platform acquisitions (§ 2.2-2012) and cooperative procurements of platforms (*§ 2.2-4304*).*

§ 2.2-4303. Methods of procurement…

E. Upon a determination in writing that there is only one source practicably available for that which is to be procured, a contract may be negotiated and awarded to that source without competitive sealed bidding or competitive negotiation. The writing shall document the basis for this determination. The public body shall issue a written notice stating that only one source was determined to be practicably available, and identifying that which is being procured, the contractor selected, and the date on which the contract was or will be awarded. This notice shall be posted in a designated public area or published in a newspaper of general circulation on the day the public body awards or announces its decision to award the contract, whichever occurs first. Public notice may also be published on the Department of General Services' central electronic procurement Web site and other appropriate Web sites.

§ 2.2-2012. Procurement of information technology and telecommunications goods and services; computer equipment to be based on performance-based specifications.

A. Information technology and telecommunications goods and services of every description shall be procured by: i) VITA for its own benefit or on behalf of other state agencies and institutions or ii) such other agencies or institutions to the extent authorized by VITA. Such procurements shall be made in accordance with the Virginia Public Procurement Act (§ 2.2-4300 et seq.) and regulations as may be prescribed by VITA.

The CIO shall disapprove any procurement that does not conform to the statewide information technology plan or to the individual plans of state agencies or public institutions of higher education.

B. All statewide contracts and agreements made and entered into by VITA for the purchase of communications services, telecommunications facilities, and information technology goods and services shall provide for the inclusion of counties, cities, and towns in such contracts and agreements. Notwithstanding the provisions of § 2.2-4301, VITA may enter into multiple vendor contracts for the referenced services, facilities, and goods and services.

C. If VITA, or any agency or institution authorized by VITA, elects to procure personal computers and related peripheral equipment pursuant to any type of blanket purchasing arrangement under which public bodies, as defined in § 2.2-4301, may purchase such goods from any vendor following competitive procurement but without the conduct of an individual procurement by or for the using agency or institution, it shall establish performance-based specifications for the selection of equipment. Establishment of such contracts shall emphasize performance criteria including price, quality, and delivery without regard to "brand name." All vendors meeting the Commonwealth's performance requirements shall be afforded the opportunity to compete for such contracts.

D. This section shall not be construed or applied so as to infringe upon, in any manner, the responsibilities for accounting systems assigned to the Comptroller under § 2.2-803.

§ 2.2-4304. Cooperative procurement.

A. Any public body may participate in, sponsor, conduct, or administer a cooperative procurement agreement with one or more other public bodies, or agencies of the United States, for the purpose of combining requirements to increase efficiency or reduce administrative expenses. Any public body that enters into a cooperative procurement agreement with a county, city, or town whose governing body has adopted alternative policies and procedures pursuant to subdivisions 9 and 10 of § 2.2-4343 shall comply with the alternative policies and procedures adopted by the governing body of such county, city, or town.

B. Subject to the provisions of §§ 2.2-1110, 2.2-1111, 2.2-1120 *and* 2.2-2012, any authority, department, agency, or institution of the Commonwealth may participate in, sponsor, conduct, or administer a cooperative procurement arrangement with private health or educational institutions or with public agencies or institutions of the several states, territories of the United States, or the District of Columbia, for the purpose of combining requirements to effect cost savings or reduce administrative expense in any acquisition of goods and services, other than professional services. In such instances, deviation from the procurement procedures set forth in this chapter and the administrative policies and procedures established to implement this chapter shall be permitted, if approved by the Director of the Division of Purchases and Supply. *Pursuant to §* 2.2-2012, such

approval is not required if the procurement arrangement is for telecommunications and information technology goods and services of every description. In instances where the procurement arrangement is for telecommunications and information technology goods and services, such arrangement shall be permitted if approved by the Chief Information Officer. However, such acquisitions shall be procured competitively. Nothing herein shall prohibit the payment by direct or indirect means of any administrative fee that will allow for participation in any such arrangement.

Existing Policy 2--Technology and Related Procurement Regulations for Sole Source Justification*: Sole source procurements, sole product procurements and sole service procurement justifications address the following questions as appropriate by regulation. The agency (e.g., VITA) must*

1. *Explain why this is the only product or service that can meet the needs of the purchasing agency.*
2. *Explain why this vendor is the only practicably available source from which to obtain this product or service.*
3. *Explain why the price quoted is considered reasonable.*
4. *Describe the efforts that were made to conduct a non-competitive negotiation to get the best possible price for the taxpayer.*

Existing Policy 3--Technology Management Policy and Related Tools: *Provides for project related requests for platform acquisitions and the use of tools referenced as the Procurement and Project Approval Request system (PPAR) and the Portfolio Management system. See Technology Management Policy.*

Existing Policy 4—Open Systems Environment*: Provides for platform operating systems that support interfaces and data/object exchanges based on open systems environment standards. See Open Systems Environment Policy.*

Existing Policy 5—Technology Assistance for Individuals with Disabilities: *Provides for the acquisition of platforms, operating systems, and productivity software that accommodate the needs of individuals with disabilities. See Technology Assistance for Individuals with Disabilities.*

Existing Standards

None.

Existing Guidelines

The following existing Guideline is related to making decisions about platform architecture.

Existing Guideline 1—Estimating Alternative Technology Systems Costs: *Provides guidance that may be used by the Commonwealth in justifying the continued procurement of any de facto platform standard that is not the only alternative for a particular performance-based need. See Estimating Alternative Technology Systems Costs.*

(This page is blank, intentionally.)

Summary of Recommendations to the ITIB

The technical recommendations provided throughout this document that will be reviewed by the ITIB are summarized below. These recommendations are presented in two groups. The groups indicate whether the domain team's preference is for the statement to be a requirement for agencies or optional guidance.

The requirements, if approved by the ITIB as written, will become part of an existing or a new ITRM policy or standard. Other existing legal or Governor-recommended requirements may also be incorporated into the ITRM framework. The ITIB will determine the final status of domain team recommendations and may move recommendations between the required and optional groupings or indicate that the recommendation will be disapproved.

The tables in this document, which present technical trends by rating technologies as obsolete, transitional, strategic or emerging, must also be approved by the ITIB. The technologies in the strategic column are acquisition standards for agencies. Their placement in this column results from a combination of the desired architectural directions for the Commonwealth (e.g., technology simplification) and an analysis of whether the technologies are approved for general use (e.g., neither bleeding edge nor planned for obsolescence by the manufacturer). These requirements will change as technologies improve and are replaced. Because over a period of time, all technologies will move from the "emerging" category to the "obsolete" category in these tables, the contents must be reviewed and revised regularly.

The requirement statements and the requirements in the strategic column of the tables interact with the operational recommendations, which are presented in the next section. For example, for a far-reaching recommendation, such as the recommendation that all desktops be Microsoft operating systems and software, the operational requirements may indicate corresponding activity for VITA. In the instance of desktops, there is a corresponding recommendation for how VITA should assess alternatives for costs and benefits to ensure a benchmark for price negotiations with Microsoft.

Requirements for Technology Acquisition (Presented to the ITIB for Concurrence)

The following tables present technology acquisition requirements for state executive branch agencies including the administrative units of higher education. These are to be presented to the ITIB for concurrence.

- Technical Table 4: Technology Use Trends for Personal Computing Devices (see Page 19)
- Technical Table 10: Technology Use Trends for Servers (see page 51)
- Technical Table 16: Technology Use Trends for Storage (see page 77)

Requirements (Recommended to the ITIB to be Part of a Future Policy or Standard)

> ***Personal Computing—Recommended Requirement 7:*** *Because desktop displays have a longer lifecycle than the computers they support, their replacement shall not be automatic at the time of a desktop replacement. Display replacement*

decisions for all agencies including administrative units of higher education must be based on customer business needs, support considerations, cost-of-ownership data, and hardware compatibility considerations. VITA shall provide separate display acquisition pricing. Also, VITA shall provide cost-benefit data and display selection criteria for CRTs and flat panel monitors.

***Personal Computing—Recommended Requirement 11**: The Commonwealth's target personal computing software architecture for new desktops and notebooks for all agencies including administrative units of higher education shall include: Microsoft Office Professional (2000 or XP), Internet Explorer, and Adobe Acrobat Reader. This software is to be provided in the standard desktop image for the Commonwealth executive branch workforce excluding administrative units in higher education. This standard shall remain in effect if cost effectiveness is confirmed by a Virginia study of alternatives and price negotiation results.*

***Personal Computing—Recommended Requirement 13**: The Enterprise Architecture establishes Microsoft Windows XP Pro as the present target operating system for Commonwealth desktops and notebooks. This standard shall apply to all agencies including the administrative units of higher education and shall remain in effect if cost effectiveness is confirmed by a Virginia study of alternatives and price negotiation results. (Note that the support lifecycle for Windows XP Professional is as follows: product availability—December 31, 2001; mainstream support—December 31, 2001 through December 31, 2006; extended support—December 31, 2006 - December 31, 2008. Computers acquired in January 2005 would be beyond extended support at the end of a 4-year lifecycle. An alternative strategy would be needed by this time.)*

***Personal Computing—Recommended Requirement 15:** The Enterprise Architecture team recommends that all agencies use the Blackberry device for both low- and high-end PDA services until VITA completes a comprehensive study of PDA needs and costs.*

The Blackberry device has a useful feature set with or without the push email services for which it is known. The benefits of using the same device for low and high-end services is reduced support staff training costs, transfer of customer skills for customers moving from low- to high-end services, proven implementation of high-end services in Virginia government, and anticipated cost effectiveness if offered to appropriate users as part of a planned tool set.

***Personal Computing-- Recommended Requirement 16:** Enterprise Architecture recommends that agencies including the administrative units of higher education change the desktop lifecycle to four years for one full year beginning in the 2004 Fiscal Year. During this year, VITA can study support costs for a sample of the four-year-old machines and determine whether annual support cost increases offset annual savings from reduced acquisitions. VITA can then recommend either a return to a three-year refresh cycle or continuance of the four-year refresh cycle following the study.*

Servers— Recommended Requirement 1: *Virginia shall limit OSs in its architecture to zOS, Solaris, HPUX, Linux, Windows and virtualization OSs for all future platform acquisitions.*

Servers—Recommended Requirement 2: *Virginia shall exclude the following operating systems from scale up contention: MPE, MVS OS 390, Unisys OS2200, VMS, AIX and OS/400.*

Servers—Recommended Requirement 3: *Virginia shall consider only Solaris, HPUX, and zOS for near-term scale-up solutions.*

Servers— Recommended Requirement 4: *Virginia shall limit scale-out consolidation platform OS contenders to Windows, Solaris, HPUX, and Linux.*

Servers— Recommended Requirement 5: *Virginia wishes to encourage hardware competition when compatible hardware is an option. When considering hardware alternatives on high-end platforms, Virginia agencies, including higher education administrative units, must require "plug-compatibility" for applications. In most instances, the hardware and OS for a high-end server are acquired as a unit from the same manufacturer. When hardware options are possible, Virginia must take care to ensure that the different hardware alternatives do not introduce variables that would change application resource management strategies, application portability, database portability, etc. The alternative must be in line with Virginia's total planned architecture. Bid requests for consolidation platforms must specify all required elements of management, maintenance, and software systems compatibility.*

Servers—Recommended Requirement 6: *Servers in the Commonwealth that provide local area network services (e.g., domain control), file services or print services must use the same operating system to facilitate central management and central consolidation opportunities. The Enterprise Architecture establishes Windows 2000, Windows 2000 Advanced Server and Windows 2003 as the target architecture standard for these servers. This standard shall remain in effect if appropriate central management systems and consolidation options are available, and if cost effectiveness is confirmed by a Virginia study of alternatives and price negotiation results.*

Servers— Recommended Requirement 10: *To promote cost-effective reuse of applications developed for other states and for governments generally, the Enterprise Architecture shall permit consideration of platforms not in the desired architecture. A specific OS may be part of the only proven implementation for selected reusable business applications, and the flexibility to choose proven solutions must be permitted. Exceptions should be provided to all agencies when warranted including higher education administrative units.*

Storage-Recommended Requirement 5: *Whenever remote consolidated storage options are cost-prohibitive, VITA and other agencies that manage storage, including administrative units of higher education, must evaluate the cost-effectiveness of local consolidated storage options for the physically collocated servers under their control.*

Platforms Generally—Recommended Requirement 4: *VITA shall centralize acquisition controls for all platforms acquired in large volumes across executive branch agencies to leverage procurements, improve interagency homogeneity, and provide equitable refresh plans within dollars allocated.*

Best Practices (Recommended to the ITIB as Possible Elements of a Future ITRM Guideline)

Personal Computing--Optional Best Practice 1: *When establishing minimum specifications for bids for low-end personal computers, VITA should use the lowest of currently available Intel, Athlon, or comparable chipsets that will meet anticipated processing needs for the proposed productivity software for the proposed refresh cycle.*

Personal Computing—Optional Best Practice 2: *VITA should select specialized chipsets for notebooks to better meet the needs of the mobile worker.*

Personal Computing--Optional Best Practice 3: *VITA should equip the standard mobile notebook computer with a wireless (e.g., IEEE 802.11 standard) interface card to enable state workers to take advantage of wireless connectivity provided in public spaces. Alternatives may be required if many agencies are concerned about allowing employee discretion in using wireless services.*

Servers—Optional Best Practice 2: *For its high-end symmetric multiprocessing needs, Virginia should use only servers that employ NUMA and similar proprietary high-end interconnection solutions until Remote Direct Memory Access (RDMA) and other future technologies become enablers of competitive scale-out solutions.*

Servers—Optional Best Practice 3: *Virginia should control the number of different management systems, third-party management solutions, and OS management vehicles used in providing both scale-up and scale-out consolidation solutions.*

Servers—Optional Best Practice 4: *Virginia should be very cautious in using Intel Itanium processors in any scale-out solutions without addressing 16 bit application use, 32 bit application performance problems, and processor heat problems in dense configurations.*

Servers—Optional Best Practice 5: *Virginia may consider Windows Datacenter for scale-up solutions in the future (e.g., perhaps by 2005). Some considerations are whether the Windows 2003 improved workload management is proven to be effective and whether cost-effective, comparable implementations are identified. For existing 32-bit applications on Windows, scale-out solutions are expected to be more effective for consolidation.*

Servers—Optional Best Practice 6: *Virginia agencies should consider all high-end platforms in the architecture as potential candidates for any application that requires high-end server performance, availability, scalability, and security.*

Servers—Optional Best Practice 7: *At present, the most appropriate opportunities for using Linux in Virginia Government are for Web hosting (e.g., proxy servers, firewalls, etc.) and cache.*

Servers—Optional Best Practice 8: *Both scale-up and scale-out solutions are strategic options for consolidation in Virginia. Scale up solutions may begin on midrange platforms that can scale to high-end size.*

Servers—Optional Best Practice 11: *Virginia should be cautious in future considerations of Intel scale-up solutions using Windows Datacenter without strong proofs of concept and/or actual implementations of similar magnitude and purpose that demonstrate cost-effective, manageable, high-quality solutions.*

Servers—Optional Best Practice 12: *Virginia should consider server appliances for cache, Web serving, storage, and other simple uses.*

Servers—Optional Best Practice 13: *Virginia's agencies that presently use OpenVMS and VAX VMS should begin to address transition options in their long-range plans.*

Servers—Optional Best Practice 22: *The Commonwealth should evaluate Linux for Web serving. Linux is opportune because of anticipated cost savings and because it is being explored worldwide as an alternative to Windows for selected lower-risk uses. Linux may be used on individual midrange to low-end servers and may be managed as a virtual server on a high-end system.*

Storage—Optional Best Practice 1: *VITA and any other agencies, including administrative units of higher education agencies that provide platform services should consider all platforms under their control when conducting capacity planning and when developing a storage plan. For consolidated servers or data-center resident applications, the managing agency should examine storage needs at the application level but design storage solutions at the data center level.*

Storage—Optional Best Practice 2: *Individual agencies that control storage, including administrative units of higher education and central storage planners (e.g., VITA), should consider a variety of storage alternatives. NAS, SAN, DAS, file servers, NAS/SAN combinations, and in/outsourced services may all be appropriate depending on storage volumes, LAN bandwidths, connectivity to central services, and other factors.*

Platforms Generally—Optional Best Practice 1: *VITA should require that desktop and server units on state contract have multiple front facing USB ports. This is an enabler for using USB key fobs for authentication, USB keys for storage, PDAs, and other USB peripherals.*

(This page is blank, intentionally.)

Operational Recommendations Approved by the Architecture Review Board (to be Implemented by VITA and Other Agencies)

Requirements

The following recommended requirements and optional practices indicate how VITA and other agencies should conduct certain aspects of their business to ensure effective decision making for architecture-related decisions. In general, many of the requirements provide for mechanisms for getting input from agencies to insure that requirements imposed will be in line with their changing business needs. Typically, VITA, or VITA functional groups such as the Enterprise Architecture staff are tasked to conduct studies, needs assessments, etc. These requirements are under the VITA Architecture Review Board because conducting these activities will require the assignment of operating resources.

Personal Computing—Recommended Requirement 1: *Enterprise Architecture Staff shall convene a personal computing platform domain team meeting twice annually to review personal computing technical trend recommendations and provide revisions as needed.*

The team shall review the target architecture recommendations for personal computing and study critical issues in-depth. The team shall be comprised of individuals knowledgeable in personal computing areas including: business needs, technologies, procurement, price negotiations, deployment, maintenance and support.

Personal Computing—Recommended Requirement 2: *To strengthen policy input for VITA decision makers, VITA Staff shall devise and track metrics on personal computing devices for executive branch agencies.*

Metrics may include costs, customer satisfaction, and environment mix within and across agencies. VITA Staff should use sampling methods, procurement systems, expenditure data, and aggregate statistics where possible to reduce metric estimation costs.

Personal Computing—Recommended Requirement 3: *VITA Staff shall examine cost and benefit data for personal computing in the aggregate (i.e., across agencies). A decision that provides the best savings across agencies may not always provide the best savings in every agency. VITA Staff must have the flexibility to implement the simpler solution that significantly benefits most agencies and users.*

Personal Computing—Recommended Requirement 4: *VITA shall centralize personal computing decisions regarding what may be procured, how frequently devices may be refreshed, how agency support is to be provided, what security methods are acceptable, and what methods of email access (e.g., wireless push email systems for PDAs) may be used.*

Personal Computing—Recommended Requirement 5: *As certain decisions regarding personal computing platforms move from agencies to VITA, VITA shall ensure an annual or more frequent process for assessing the changes in personal computing business needs within and across agencies.*

Personal Computing—Recommended Requirement 6: *VITA shall provide location-based personal computing support options for geographically dispersed agency groups when central services are inadequate to meet customer needs. Costs and benefits of location-based services must be separately evaluated.*

Personal Computing—Recommended Requirement 8: *When establishing minimum bid specifications for personal computers, VITA shall include CD writers as standard output devices. Floppy drives and DVD readers should be optional. The acquisition of DVD writers shall be discouraged until a single standard is ratified. This requirement applies to agencies including the administrative units of higher education.*

Personal Computing—Recommended Requirement 9*: VITA shall determine the productivity software needs in the Commonwealth (e.g., percentage of the workforce that requires various combinations of the individual office software offerings including word processing, presentation, spreadsheet, and database software) for considering the most cost-effective desktop, laptop, PDA, and base image alternatives.*

Needs information can be used in estimating the costs of personal computing alternatives and the costs of modifying the desktop base image for those groups needing additional personal or agency functionality.

Personal Computing—Recommended Requirement 10: *Enterprise Architecture Staff shall periodically convene a team to determine the best antivirus software for inclusion in a desktop base image given: relative protection levels provided, how updates are accomplished, maintenance costs, impact on the network, company history, company plans, and software/license costs. The decision must be coordinated with the network antivirus engine selection decision. The team shall involve members of the Platform, Network, and Security Domain Teams. Agencies should use a highly rated antivirus software (e.g., by Norton (Symantec), McAfee, Panda, PC-cillin, or Eset) until the Enterprise Architecture recommendations are released.*

Personal Computing—Recommended Requirement 12*: VITA shall develop starting point, typical base images for the most commonly needed desktop and notebook computer types to reduce setup decision making and costs. This should include appropriate software setup and system lockdown policies.*

Personal Computing—Recommended Requirement 14: *The Enterprise Architecture team recommends that VITA conduct a comprehensive study of PDA needs, functions, benefits, and costs. The study team should include platform domain participants, network domain experts, PDA support and PDA users. The Enterprise Architecture team will use this information to recommend future PDA*

directions for the Commonwealth. Because PDA product and service offerings change frequently, this group should review its recommendations twice annually.

Servers—Recommended Requirement 7: *VITA shall examine the feasibility, costs, and benefits of standardizing on Exchange as an Email Server. The study shall consider whether centralizing email is cost effective and whether standardizing on Microsoft Exchange or another enterprise solutions is cost effective. With network services standardized across agencies, opportunities for providing central utilities improve. Resource directories including those related to email may be centrally controlled and locally managed.*

Servers—Recommended Requirement 8: *Individual agencies, including higher education administrative units, and VITA shall ensure that servers are under a maintenance agreement for the planned life of the server.*

Servers—Recommended Requirement 9: *Individual agencies, including higher education administrative units, and VITA shall examine consolidated storage alternatives whenever considering acquisitions of file servers.*

Storage—Recommended Requirement 1: *VITA shall require that agencies provide periodic capacity planning and storage planning data. The availability of planning data will improve agency and central storage solutions and backup and disaster recovery solutions.*

Storage—Recommended Requirement 2: *VITA Staff shall use information from agency capacity and storage planning to investigate the feasibility of providing central storage utility services.*

Storage—Recommended Requirement 3: *To reduce escalating storage costs, VITA shall consider storage consolidation opportunities when considering utility services for central handling. Potential utility services that would have large storage needs and/or growing storage needs are email services and Web hosting services.*

Storage—Recommended Requirement 4: *VITA shall explore opportunities to provide cost-effective, centrally managed storage services that can meet the needs of small and medium applications across agencies.*

Note: At present, it is generally cost-prohibitive to attach servers of small applications to a SAN. As iSCSI becomes a recognized standard and iSCSI storage becomes more readily available, the use of this protocol will drastically reduce connection costs and increase the likelihood of having central storage for the application servers of all agencies. iSCSI allows the substitution of inexpensive devices (e.g., Ethernet devices) for expensive Fibre Channel devices and the transmission of storage traffic over existing local and wide-area networks. What this means to storage planning is that one solution may meet a broader range of needs in a cost-effective manner.

Storage-Recommended Requirement 6*: VITA must offer capacity planning and storage planning services to assist agencies in determining their future requirements.*

Platforms Generally—Recommended Requirement 1: *VITA shall consider business security requirements up front when making decisions for all platforms from personal computing devices to enterprise servers.*

Platforms Generally—Recommended Requirement 2: *VITA shall design systems with interchangeable components to support field servicing of hardware and software.*

Platforms Generally—Recommended Requirement 3: *VITA shall design platforms for remote administration, diagnosis, and systems management.*

Platforms Generally—Recommended Requirement 5: *VITA shall deploy a central lab for use in: 1) testing emerging platform technologies and their general applicability to the Commonwealth's computing architecture; 2) partnering with individual Commonwealth entities to provide a focused approach for matching technology solutions with identified business needs; and 3) communicating results to stakeholders.*

Best Practices Approved by the Architecture Review Board

Personal Computing--Optional Best Practice 4: *Virginia should conduct its own controlled study of the costs and benefits of desktop provision alternatives and other personal computing alternatives as soon as possible. Options for support, hardware, and software (e.g., OS, productivity software, antivirus software and management software) would be addressed. The proposed study for desktops would provide information on alternatives to the presently used Microsoft desktop solutions, which could be used to establish reasonable cost targets for future Microsoft product negotiations. If unsuccessful in Microsoft price negotiations, Virginia would then have a viable alternative strategy to implement that would costs less and meets business needs. When comparing personal computing alternatives, Virginia should:*

- *Establish lifecycles for desktop and notebook hardware that are appropriate for the specific solution. For example, Microsoft products may require a 3-year refresh due to escalating resource usage by office suite upgrades and an open systems solution might have a lifecycle of 5 years.*
- *Compare the following solutions at a minimum: 1.) a Microsoft OS with Microsoft Office Professional 2003; 2.) a Microsoft OS with an alternative office suite (perhaps StarOffice, Corel, and OpenOffice); and 3.) an Open Systems solution such as Linux with OpenOffice or Sun's Java Desktop.*
- *Compare workforce training/retraining cost using training to the functional requirements of typical jobs for each alternative suite.*
- *Separately calculate one-time changeover costs including application modifications.*
- *Compare support staffing and support staff training requirements (including development staff training).*

- *Use an appropriate mix of current hardware and software as the baseline from which change costs are to be calculated.*
- *Obtain and use appropriate information on support/programming skills of the current Commonwealth technical workforce.*

Personal Computing—Optional Best Practice 5: *VITA should notify agency heads that floppy disk drives are no longer standard equipment on new computers. Agencies should implement plans that mitigate the effects of this change.*

Personal Computing--Optional Best Practice 6: *Enterprise Architecture recommends that agencies and central services do not upgrade operating systems software or office productivity software during the life of the desktop.*

One concern about using this approach is that support staff may have to support many versions. The organizing of personal computer support teams by OS/software version combinations rather than by agency may mitigate this problem. This would also facilitate the tracking of problems by version of software and year of hardware.

Servers—Optional Best Practice 1: *Virginia should determine if cost savings can be realized by identifying and replacing any serial ring NUMA platforms.*

Servers—Optional Best Practice 6: *Virginia agencies should consider all high-end platforms in the architecture as potential candidates for any application that requires high-end server performance, availability, scalability, and security.*

Servers—Optional Best Practice 9: *Virginia should define platform strategies by workload type.*

Servers—Optional Best Practice 10: *Virginia should leverage its business volume, its central control, and the cost-benefits of simplification in all platform procurement and scaling decisions.*

Servers— Optional Best Practice 14: *Virginia should track data on staffing, staff retirement plans, staff skills and staff retraining interests.*

Servers— Optional Best Practice 15: *Virginia should track data on hardware and software retirement plans.*

Servers— Optional Best Practice 16: *Virginia should first define its consolidation options for non-file-service storage (i.e., block services storage) and then define consolidation platform management services, email consolidation, file/print services consolidation, and web hosting services consolidation.*

Servers—Optional Best Practice 17: *When conducting cost-benefit analyses for an application, individual agencies or central services should consider the full costs of server alternatives and not just up-front costs.*

Servers—Optional Best Practice18: *Individual agencies and VITA should consider the agency's goals, the Commonwealth's goals, and Enterprise Architecture guidance when selecting server solutions.*

Servers—Optional Best Practice19: *Individual agencies and VITA should employ manufacturer-specific systems setup policies and best practices.*

Servers—Optional Best Practice 20: *Individual agencies and VITA should ensure that the maintenance support response-time is in line with business needs for applications on each specific server.*

Servers—Optional Best Practice 21: *When an agency employs a different server solution in an otherwise homogeneous shop, the agency should consider supporting the different server by using in-sourcing (i.e., contracting with another agency or with VITA) or outsourcing alternatives.*

Servers—Optional Best Practice 23: *If the Commonwealth requires use of Windows 2000 (or higher) as the operating system of choice for all domain control functions, the Commonwealth should implement a centrally controlled forest structure across all executive branch agencies. A forest (also known as an enterprise) is a collection of domains and domain trees.*

Platforms Generally--Optional Best Practice 2: *VITA should include opportunities for annual renegotiations in all high-volume outsourcing contracts to ensure that outsourcing remains cost-effective as market and other conditions change.*

Glossary

10GigE –10 Gigabit Ethernet Service

8, 16, 32, and 64 Bit Architectures –a CPU is designed to carry out instructions on data that is in memory. The way it does this is significantly different for 8 bit and 64 bit architectures. The greater the number of bits, the more options there are that must be considered for how instructions are handled. Options include the complexity of the instruction set, the width of the data path, the number of registers, and the number of instructions that may execute per clock cycle. A program written for a 64-bit architecture may not be as fast as one written for a 32-bit architecture, but it may provide other advantages.

802.11a card–wireless interface that provides up to 54 Mbps service using an Orthogonal Frequency Division Multiplexing (OFDM) modulation technique for signal transmission in the 5.5 GHz spectrum

802.11b card–wireless interface that provides up to 11 Mbps service using Frequency Hopping Spread Spectrum (FHSS) modulation technique for signal transmission in the 2.4 GHz spectrum; also called WiFi. Interference from cordless phones and microwave ovens may be a problem.

802.11g cards –wireless interface that provides up to 54 Mbps service using an Orthogonal Frequency Division Multiplexing (OFDM) modulation technique for signal transmission in the 2.4 GHz spectrum. Backwards compatibility is maintained with 802.11b. Interference from cordless phones and microwave ovens may be a problem

Accelerated Graphics Port (AGP) –A bus specification by Intel, which gives low-cost 3D graphics cards faster access to main memory on personal computers than the usual PCI bus. AGP dynamically allocates the PC's normal RAM to store the screen image and to support texture mapping, z-buffering and alpha blending. Intel built AGP into a chipset for its Pentium II microprocessor. AGP cards are slightly longer than a PCI card. AGP operates at 66 MHz, doubled to 133 MHz, compared with PCI's 33 MHz. AGP allows for efficient use of frame buffer memory, thereby helping 2D graphics performance as well. (FOLDOC)

Advanced Intelligent Tape (AIT) –A form of magnetic tape and drive using AME developed by Sony for storing large amounts of data. An AIT can store over 50 gigabytes and transfer data at six megabytes/second (in February 1999). AIT features high-speed file access, long head and media life, the ALDC compression algorithm, and a MIC chip. (FOLDOC)

Agency –generally means executive branch agency, which includes higher education agencies; however, due to confusion introduced by scope restrictions on selected responsibilities of the newly created Virginia Information Technologies Agency (VITA), recommended requirements in this report will apply as follows. Tabled technology acquisition and use requirements in this report will apply to all executive branch agencies including the administrative units of higher education. Recommended requirement statements will apply to higher education administrative units only if so noted within the statement.

AMD Opteron –the AMD 8131 chipset, which improves connection speeds by employing two independent, high-performance PCI-X bus bridges, integrated with a high-speed HyperTransport technology tunnel. The tunnel function provides connection capability to other downstream HyperTransport technology devices, allowing greater system flexibility. (www.AMD.com)

Appliance –server hardware configured with server software and optimized for simple functions such as Web page serving.

Asynchronous Mirroring –data to be stored are written synchronously (with acknowledgement to the application) to a cache resource and then written asynchronously (without acknowledgement) to a primary store and a mirrored (copy of the primary) store.

Asynchronous Transfer Mode (ATM) –ATM (asynchronous transfer mode) is a dedicated-connection switching technology that organizes digital data into 53-byte cell units and transmits them over a physical medium using digital signal technology. Individually, a cell is processed asynchronously relative to other related cells and is queued before being multiplexed over the transmission path. Because ATM is designed to be easily implemented by hardware (rather than software), faster processing and switch speeds are

possible. The pre-specified bit rates are either 155.520 Mbps or 622.080 Mbps. Speeds on ATM networks can reach 10 Gbps. (searchNetworking.com)

ATA Disk –ATA (Advanced Technology Attachment) is the official name that American National Standards Institute group X3T10 uses for what the computer industry calls Integrated Drive Electronics (IDE). An ATA disk is a serial drive used for data storage, which may be used in a disk array. It is cheaper than the technology typically used in RAID. Also, a type of drive controller.

Athlon Chipset –AMD microprocessor, delivered in mid-1999, was the first to support a 200 MHz bus. In March 2000, AMD announced the first 1 gigahertz PC microprocessor in a newer version of the Athlon. The current AMD Athlon XP 3000+ performs better than the Intel Pentium 4 3.06 GHz chip in office productivity (PWC audit).

Authentication –authentication is the process of determining whether someone or something is, in fact, who or what it is declared to be. In private and public computer networks (including the Internet), authentication is commonly done through the use of logon passwords. Knowledge of the password is assumed to guarantee that the user is authentic. Logically, authentication precedes authorization (although they may often seem to be combined). (searchSecurity.com)

Base Image –This term is used in this report to indicate a starting point for a hard disk image that may be used as is or further modified to meet agency user needs with users placed in as large a group as possible based on commonality of requirements. All secretaries may have one base image and all programmers, another. The image is a copy of the configured operating system and software on the desktop, laptop or other device. Microsoft provides instructions for establishing, compressing and distributing such images. See below.

> "Some organizations deploy a complete user system at one time, including Microsoft® Windows® software, device drivers, Microsoft Office 2003 applications, and custom settings. In this scenario, you install the entire system onto a test computer, and then you create an image of the hard disk to copy to users' computers.
>
> Installing Office with a complete user system is almost as fast as installing Office by itself. It is a particularly efficient way to configure new computers or to restore a computer to its original state. When you distribute the hard disk image to users, everything on the computer is replaced by your custom configuration, so users must back up any documents or other files they want to keep."

Biometrics –the science and technology of measuring and statistically analyzing biological data. In information technology, biometrics usually refers to technologies for measuring and analyzing human body characteristics such as fingerprints, eye retinas and irises, voice patterns, facial patterns, and hand measurements, especially for authentication purposes. Fingerprint and other biometric devices consist of a reader or scanning device, software that converts the scanned information into digital form, and wherever the data is to be analyzed, a database that stores the biometric data for comparison with previous records. When converting the biometric input, the software identifies specific points of data as match points. The match points are processed using an algorithm into a value that can be compared with biometric data scanned when a user tries to gain access.

Blackberry –a brand of personal digital assistant hardware; an email service; or the company that offers the hardware and service. The hardware/OS, which was originally a RIM product, is called a Blackberry and comes in a variety of form factors. Most notably, the Blackberry has a small keyboard for data input and offers standard personal information management capabilities. The Blackberry service is a live push email service, which may be controlled by a local server or a Blackberry company server.

Block Service – a block is the unit in which data is stored and retrieved on disk and tape devices. Blocks are the atomic unit of data recognition (through a preamble and block header). A block service is the process of storing and retrieving blocks of data (as opposed to files).

Bluetooth –a computing and telecommunications industry specification that describes how mobile phones, computers, and personal digital assistants (PDAs) can easily interconnect with each other and with home and business phones and computers using a short-range wireless connection. Using this technology, users of cellular phones, pagers, and personal digital assistants such as the PalmPilot will be able to buy a three-in-one phone that can double

as a portable phone at home or in the office, get quickly synchronized with information in a desktop or notebook computer, initiate the sending or receiving of a fax, initiate a print-out, and, in general, have all mobile and fixed computer devices be totally coordinated. Bluetooth requires that a low-cost transceiver chip be included in each device. The transceiver transmits and receives in a previously unused frequency band of 2.45 GHz that is available globally (with some variation of bandwidth in different countries). In addition to data, up to three voice channels are available. Each device has a unique 48-bit address from the IEEE 802 standard. Connections can be point-to-point or multipoint. The maximum range is 10 meters. Data can be exchanged at a rate of 1 megabit per second (up to 2 Mbps in the second generation of the technology). A frequency hop scheme allows devices to communicate even in areas with a great deal of electromagnetic interference. Built-in encryption and verification are provided. (serachMobileComputing.com)

CARS –Commonwealth Accounting and Reporting System. Virginia's mandatory accounting system.

Chipset –a group of microchips designed to work together and which are sold as a unit. Colloquially, chipsets are referenced by brand name and version (e.g., Pentium 4). Example components are the bus controller (USB, PCI, etc.) and the processor (CPU).

CISC –complex instruction set computer. A processor type in which each instruction can perform several low-level operations such as memory access, arithmetic operations or address calculations. For example, the Intel Pentium is a CISC design. (Modified from www.FOLDOC.org)

Cluster –1) In a computer system, a cluster is a group of servers and other resources that act like a single system and enable high availability and, in some cases, load balancing and parallel processing. See clustering. [Clustering has been available since the 1980's with VAX and is called Sysplex in the IBM S/390 world.] 2) In personal computer storage technology, a cluster is the logical unit of file storage on a hard disk; it's managed by the computer's operating system. Any file stored on a hard disk takes up one or more clusters of storage. A file's clusters can be scattered among different locations on the hard disk. The clusters associated with a file are kept track of in the hard disk's file allocation table (FAT). When you read a file, the entire file is obtained for you and you aren't aware of the clusters it is stored in. (Whatis.com)

CMP – cellular multiprocessing (a parallel architecture). The term cellular multiprocessing was coined by Unisys. Unisys developed a system where computers communicate as clustered machines through a high-speed bus, rather than through communication protocols such as TCP/IP.
The Unisys system is based on Intel processors, initially the Pentium II Xeon. It is scalable from four up to 32 processors, which can be clustered or partitioned in various ways. For example a sixteen-processor system could be configured as four Windows systems (each functioning as a four-processor symmetric multiprocessing system), or an 8-way Windows and an 8-way Unix system.

CMT – chip multithreading. A method to speed up processing within a chipset.

Common Internet File System (CIFS) – is a proposed standard protocol that lets programs make requests for files and services on remote computers on the Internet. CIFS uses the client/server-programming model. A client program makes a request of a server program (usually in another computer) for access to a file or to pass a message to a program that runs in the server computer. The server takes the requested action and returns a response. CIFS is a public or open variation of the Server Message Block Protocol (SMB) developed and used by Microsoft. The SMB Protocol is widely used in today's local area networks for server file access and printing. Like the SMB protocol, CIFS runs at a higher level than and uses the Internet's TCP/IP protocol. CIFS is viewed as a complement to the existing Internet application protocols such as the File Transfer Protocol (FTP) and the Hypertext Transfer Protocol (HTTP). CIFS lets you:
-Get access to files that are local to the server and read and write to them
-Share files with other clients using special locks
-Restore connections automatically in case of network failure
-Use Unicode file names
In general, CIFS gives the client user better control of files than the File Transfer Protocol. It provides a potentially more direct interface to server programs than currently available through the Web browser and its use of the HTTP protocol.
CIFS is an Open Group standard, X/Open CAE Specification C209, and has been proposed to the

Internet Engineering Task Force (IETF) as an Internet application standard. (Whatis.com)

Compact Flash – A small flash memory module. The memory chips are enclosed in a plastic case and retain data after they are removed from the system. The most common uses for these are in pagers, handheld computers, cell phones, digital cameras, and audio players. (www.crucial.com)

Digital Linear Tape (DLT) –is a form of magnetic tape and drive system used for computer data storage and archiving. A special compression algorithm, known as Digital Lempel Ziv 1 (DLZ1), facilitates storage and retrieval of data at high speeds and in large quantities. In the DLT drive, data is written on the tape in dozens of straight-line (linear) tracks, usually 128 or 208. Some cartridges can hold 70 gigabytes (GB) of data when compression is used. A variant of DLT technology, called SuperDLT, makes it possible to store upwards of 100 GB on a single cartridge. The SuperDLT drive can transfer data at speeds of up to 10 megabytes per second (Mbps). (searchStorage.com)

DASD –Direct Access Storage Device

EPIC – Explicitly Parallel Instruction Computing. Intel's Itanium 2 processor uses this instruction set rather than CISC.

E-SAN –an Ethernet-switched storage area network

ESCON (Enterprise Systems Connection) –is a marketing name for a set of IBM and vendor products that interconnect S/390 computers with each other and with attached storage, locally attached workstations, and other devices using optical fiber technology and dynamically modifiable switches called ESCON Directors. In IBM mainframes, the local interconnection of hardware units is known as channel connection (and sometimes as local connection to distinguish it from remote or telecommunication connection). ESCON's fiber optic cabling can extend this local-to-the-mainframe network up to 60 kilometers (37.3 miles) with chained Directors. The data rate on the link itself is up to 200 Mbps (million bits per second) and somewhat less when adapted to the channel interface. Vendor enhancements may provide additional distance and higher amounts of throughput. ESCON may be used for a SAN. (search390.com)

Ethernet –A local-area network (LAN) protocol that is specified in IEEE 802.3 and that uses CSMA-CD to provide 10 Mbps service over copper. Switched Ethernet provides faster service (e.g., 100 Mbps Ethernet, 10GigE)

eVA –electronic government Virginia. The name for the procurement system used in Virginia government.

EWTA (Enterprise-wide Technical Architecture) –Enterprise Architecture has business and technical components. All of the technical components taken together are called the Enterprise Wide Technical Architecture. In Virginia, the technical architecture is divided into eight domains, one of which is the platform domain.

Fabric –a term used to reference a switching system such as a SAN system, and ATM system or a Frame Relay system. The term, fabric, is used to indicate the complex interplay of hardware and software in the switching process that may involve numerous paths.

FICON (Fiber Connectivity) –is a high-speed input/output (I/O) interface for mainframe computer connections to storage devices. As part of IBM's S/390 server, FICON channels increase I/O capacity through the combination of a new architecture and faster physical link rates to make them up to eight times as efficient as ESCON (Enterprise System Connection), IBM's previous fiber optic channel standard. FICON channel features include:
-A mapping layer based on the ANSI standard Fibre Channel-Physical and Signaling Interface (FC-PH), which specifies the signal, cabling, and transmission speeds
-100 Mbps bi-directional link rates at distances of up to twenty kilometers, compared to the 3Mbps rate of ESCON channels at distances of up to three kilometers.
-More flexibility in terms of network layout, because of the greater distances
-Compatibility with any installed channel types on any S/390 G5 server
-Bridge feature, which enables support of existing ESCON control units
-Requires only one channel address
-Support for full-duplex data transfer, which enables simultaneous reading and writing of data over a single link
-multiplexing, which enables small data transfers to be transmitted with larger ones, rather than having to

wait until the larger transaction is finished (searchStorage.com)

Emerging –rating used in this document to classify technologies. The Virginia Enterprise Architecture promotes only evaluative deployments of this technology. This technology may be in development or may require evaluation in government and university settings.

Fibre Channel Arbitrated Loop (FC-AL) – a fast serial bus interface standard intended to replace SCSI on high-end servers. FC-AL has a number of advantages over SCSI. It offers higher speed: the base speed is 100 megabytes per second, with 200, 400, and 800 planned. Many devices are dual ported, i.e., can be accessed through two independent ports, which doubles speed and increases fault tolerance. Cables can be as long as 30 m (coaxial) or 10 km (optical). FC-AL enables self-configuring and hot swapping and the maximum number of devices on a single port is 126. Finally, it provides software compatibility with SCSI.
Despite all these features FC-AL is unlikely to appear on desktops anytime soon, partly because its price, partly because typical desktop computers would not take advantage of many of the advanced features. On these systems FireWire has more potential. (FOLDOC)

FireWire –a high performance serial bus (or IEEE 1394). FireWire is a 1995 Macintosh/IBM PC serial bus interface standard offering high-speed communications and isochronous real-time data services. 1394 can transfer data between a computer and its peripherals at 100, 200, or 400 Mbps, with a planed increase to 2 Gbps. Cable length is limited to 4.5 m but up to 16 cables can be daisy-chained yielding a total length of 72 m.
It can daisy chain together up to 63 peripherals in a tree-like structure (as opposed to SCSI's linear structure). It allows peer-to-peer device communication, such as communication between a scanner and a printer, to take place without using system memory or the CPU. It is designed to support plug-and-play and hot swapping. Its six-wire cable is not only more convenient than SCSI cables but can supply up to 60 watts of power, allowing low-consumption devices to operate without a separate power cord.
Some expensive camcorders have included this bus since autumn 1995. It is expected to be used to carry SCSI, with possible application to home automation using repeaters. (FOLDOC)

FC-IP –Fibre Channel Internet Protocol, a Fibre Channel Block wrapped in an IP packet.

File Service –the process of storing and retrieving files (as opposed to blocks of data).

File Transfer Protocol (FTP) –a client-server protocol that allows a user on one computer to transfer files to and from another computer over a TCP/IP network. Also, used to reference the client program that the user executes to transfer files. It is defined in STD 9, RFC 959. (FOLDOC)

Flash Memory –a non-volatile memory device that retains its data after the power is removed. (www.crucial.com)

Freedom of Information Act (FOIA) –a chapter of the Code of Virginia. 2.2-3700, which addresses a citizen's right to access state government information.

GSM (Global System for Mobile communication) –a digital mobile telephone system that is widely used in Europe and other parts of the world.

High-end Servers –in this report, defined as servers with a greater than 16 processor scale-up limit and typically costing more than $250,000.

Host –the term "host" is used in several contexts, in each of which it has a slightly different meaning:
1) In Internet protocol specifications, the term "host" means any computer that has full two-way access to other computers on the Internet. A host has a specific "local or host number" that, together with the network number, forms its unique IP address. If you use Point-to-Point Protocol to get access to your access provider, you have a unique IP address for the duration of any connection you make to the Internet and your computer is a host for that period. In this context, a "host" is a node in a network.
2) For companies or individuals with a Web site, a host is a computer with a Web server that serves the pages for one or more Web sites. A host can also be the company that provides that service, which is known as hosting.
3) In IBM and perhaps other mainframe computer environments, a host is a mainframe computer (which is now usually referred to as a "large server"). In this context, the mainframe has intelligent or "dumb" terminals (or emulation) attached to it that use it as a host provider of services. (The server/client relationship is a programming model independent of this contextual usage of "host.")

4) In other contexts, the term generally means a device or program that provides services to some smaller or less capable device or program. (Whatis.com)

Human Resources (HR, DHRM) –this term has three meanings as used in this report.
1.) Person hours available to perform work on an information technology project
2.) Data systems that specialize in employee related information and functions
3.) The department or office within an agency or an enterprise that deals with employee information, performance, hiring, firing, benefits, EEO, training and related functions
4.) DHRM is the state agency in Virginia, Department of Human Resource Management.

HTTP –Hypertext Transport Protocol

Hyper-threading –a term used by Intel to describe multithreading functionality in a chipset that may be turned on and off. Some argue that an enterprise should turn the capability off until they are able to determine whether it results in a performance boost or drop for the type of processing they need. The following definition is from Intel.

> Hyper-Threading Technology allows two threads (or parts of a software program) to execute simultaneously on a single Pentium 4 processor. A Hyper-Threading Technology-aware operating system such as Microsoft Windows* XP Professional "sees" two virtual processors, instead of a single physical Pentium 4 processor. By using resources that might otherwise sit idle, the Pentium 4 Processor with Hyper-Threading Technology delivers noticeable performance increases over current software in a multitasking environment, no code modifications needed.

IEEE (Institute of Electrical and Electronics Engineers, Inc.) A standards group for communications. www.ieee.org

InfiniBand (IB)–an emerging standard intended as an interconnect for processor and I/O systems and devices (see the InfiniBand Trade Association web site at http://www.InfiniBandta.org for details). IP is one type of traffic (and a very important one) that could use this interconnect. InfiniBand would benefit greatly from a standardized method of handling IP traffic on IB fabrics. It is also important to be able to manage InfiniBand devices in a common way.
The InfiniBand working group (http://www.ietf.org/html.charters/ipoib-charter.html) has two tasks:
- Specify the protocols and encapsulations to transport IPv4/v6 over an InfiniBand fabric.
- Specify a set of management information base or MIB objects to allow management of the InfiniBand fabric itself.

Infrared –electromagnetic waves in the frequency range just below visible light corresponding to radiated heat.

I/O –Input/Output

Intel Centrino –Centrino is a technology package from Intel that provides built-in wireless support for laptop computers while making it possible to run a laptop all day (up to seven hours) without a battery recharge. Through Centrino, Intel hopes to encourage corporations and users to replace their current laptops with a newer, more mobile version. Analysts suggest that a more mobile laptop may in time replace the desktop computer as well.
The Centrino package consists of:
-The Pentium M processor
-The 855 chipset Family
-The PRO/Wireless network connection
In addition to a 400 MHz system bus and a 1 MB L2 cache, the M processor has the ability to use only the voltage that applications demand. The 855 Chipset supports up to 2 GB of double data rate (DDR) memory and USB 2.0 for faster data transfer. The PR/Wireless connection supports WiFi (802.11b) and power functions designed to maximize battery life.

Intel Itanium Chipset –Itanium is Intel's first microprocessor that is based on the 64-bit architecture known as IA-64. Developed under the code name of Merced, Itanium and its underlying architecture are expected to provide a foundation for the next-generation of software for the server and high-end workstation markets.
Intel plans to follow Itanium with additional IA-64 microprocessors, which have the code names of McKinley, Madison, and Deerfield.
In addition to supporting a 64-bit processor bus and a set of 28 registers, the 64-bit design allows access to a very large memory (VLM). In addition, the architecture exploits features in Explicitly Parallel Instruction Computing (EPIC), a joint Intel and Hewlett-Packard development effort. These provide advances in the parallel processing handling of

computer instructions known as predication and speculation.
An additional Itanium feature includes a Level 3 (L3) cache memory, to supplement the current L1 and L2 cache memories found in most of today's microcomputers.
Most applications in use today are based on a 32-bit microprocessor architecture, and are designed for up to 4 gigabytes of memory. However, with application access to ever-larger databases becoming more important, many of the leading software and hardware suppliers in the computer industry have already begun to develop systems and applications for the Itanium and its ability to handle 64-bit address space.
One feature of Itanium is its use of a "smart compiler" to optimize how instructions are sent to the processor. This approach allows Itanium and future IA-64 microprocessors to process more instructions per clock cycle (IPCs). (IPCs can be used along with clock speed in terms of megahertz (MHz) to indicate a microprocessor's overall performance.) (Whatis.com)

Intel XEON – the Intel® Xeon™ processor MP family is designed specifically for mid-tier servers performing key business functions such as collaboration, application serving, enterprise resource planning, and business intelligence. The Intel Xeon processor MP features Hyper-Threading technology, Integrated Three-Level cache architecture and Intel® NetBurst™ microarchitecture.
The Intel® Xeon™ Processor is designed for dual-processor server and workstation platforms. It does not have the three-level cache.

Internet Protocol (IP) –a communications protocol, which routes packets of data from one address on the Internet to another. IPv4 routes each packet based on a 32-bit destination address called an IP address (e.g., 123.122.211.111).

Internetworking –a term used by Cisco, BBN, and other providers of network products and services as a comprehensive term for all the concepts, technologies, and generic devices that allow people and their computers to communicate across different kinds of networks. (searchNetworking.com)

IrDA (Infrared Data Association)—is an industry-sponsored organization set up in 1993 to create international standards for the hardware and software used in infrared communication links. An IrDA port is an infrared port. In this special form of radio transmission, a focused ray of light in the infrared frequency spectrum, measured in terahertz, or trillions of hertz (cycles per second), is modulated with information and sent from a transmitter to a receiver over a relatively short distance. Infrared radiation (IR) is the same technology used to control a TV set with a remote control.
Infrared data communication is playing an important role in wireless data communication due to the popularity of laptop computers, personal digital assistants (PDAs), digital cameras, mobile telephones, pagers, and other devices. Infrared communication involves a transceiver (a combination transmitter and receiver) in both devices that communicate.
IR can be also be used for somewhat longer interconnections and is a possibility for interconnections within local area networks. The maximum effective distance is somewhat less than 1.5 miles and the maximum projected bandwidth is 16 megabits per second. Since IR is line-of-sight light transmission, it is sensitive to fog and other atmospheric conditions.
(searchMobileComputing.com)

iSCSI (Internet Small Computer System Interface) –a protocol for transmitting a SCSI block wrapped in an IP packet.

ITIB (Information Technology Investment Board) –created by the General Assembly to perform "agency head" roles for the Virginia Information Technologies Agency.

ITRM –Information Technology Resource Management—identifier used to indicate official IT policies, standards, and guidelines permitted by the Virginia General Assembly for the control and management of IT resources in the Commonwealth.

Jaz Drive –Iomega Corporation's drive, which takes removable one or two gigabyte disk cartridges that contain conventional hard disks.

Just a Bunch of Disks (JBODS) –a storage subsystems using multiple independent disk drives, as opposed to one form of RAID or another.

Key Fob –a type of security token: a small hardware device with built-in authentication mechanisms. Just as the keys held on an ordinary real-world key chain or fob control access to the owner's home or car, the mechanisms in the key fob control access to network services and information. The key fob (and similar

devices, such as smart cards) provide two-factor authentication: the user has a personal identification number (PIN), which authenticates them as the device's owner; after the user correctly enters their PIN, the device displays a number which allows them to log on to the network. Because a key fob is a physical object, it is easy for the owner to know if it has been stolen. In comparison, a password can be stolen (or guessed) and used for an extended period before -- if ever -- the theft is detected. (searchSecurity.com)

Linear Tape Open (LTO) –an open standard for a backup tape system, which provides formats for both fast data access and high storage capacity, developed jointly by Hewlett-Packard, IBM, and Seagate. IBM released the first LTO products in August, 2000.
Like existing tape systems, LTO uses a linear multi-channel bi-directional format. LTO adds to existing technologies timing-based servo (a device that automates a process of error correction for a mechanism), hardware data compression, enhanced track layouts, and efficient error correction code.
LTO was developed in two different formats - one for fast data access and another for greater storage capacity. The Accelis format uses 8mm-wide tape on a two-reel cartridge that loads at the mid-point of the tape to provide fast data access, specifically for read-intensive applications, such as online searches and retrieval functions. The Ultrium format uses a single reel of half-inch wide tape to maximize storage capacity, specifically for write-intensive applications, such as archival and backup functions. Early products using the Accelis format offer a 25 gigabyte capacity for uncompressed data, while Ultrium based-products offer a 100 gigabyte capacity. Both formats provide transfer rates of 10 - 20 Mbps. While these figures are not unheard of in other technologies, LTO specifications include plans for expected increases that will double current rates with each of the next three generations of products.

Linux –a UNIX-like operating system that was designed to provide personal computer users a free or very low-cost operating system comparable to traditional and usually more expensive UNIX systems. Linux has a reputation as a very efficient and fast-performing system. Linux's kernel (the central part of the operating system) was developed by Linus Torvalds at the University of Helsinki in Finland. To complete the operating system, Torvalds and other team members made use of system components developed by members of the Free Software Foundation for the GNU Project.
Linux is a remarkably complete operating system, including a graphical user interface, an X Window System, TCP/IP, the Emacs editor, and other components usually found in a comprehensive UNIX system. Although copyrights are held by various creators of Linux's components, Linux is distributed using the Free Software Foundation's copyleft stipulations that mean any modified version that is redistributed must in turn be freely available. (searchEnterpriseLinux.com)

Local Area Network (LAN) –1. a private computer network generally on a user's premises and operated within a limited geographical area.

MagStar –a family of IBM proprietary tape equipment and products.

Metropolitan Area Network (MAN)—a private wide area network that addresses the needs of a city —typically of dark fiber, that may be lit with public services or Gigabit Ethernet.

Midrange to Low-end Servers –in this report, servers costing $50, 000 or less are typical midrange to low-end servers. These servers would usually have one to four processors, but could have as many as 8 or 16 processors. When the midrange computer is a scaled-down version of a high-end server, it may cost substantially more.

Mirroring –writing the same data in two locations.

Mobile –the ability to move around, it also refers to anything that can be moved around (or transported) and still functioning properly. It usually describes handheld devices, such as PDAs and cell phones (that is, mobile phones), but it can also refer to laptops or other portable devices. (netlingo.com)

Mozilla –the open source web browser, designed for standards-compliance, performance, and portability, whose development is coordinated by mozilla.org. The Mozilla project started in March 1998 when Netscape Communications Corporation released the source code of Netscape Communicator. The now abandoned version based on that code is referred to as "Mozilla Classic". Since then, much has been rewritten, including the layout engine, the networking library, and the front-end.
Mozilla.org was set up by Netscape in January 1998 to coordinate development and to provide a point of

contact for interested people. Mozilla 1.0 was finally released on 2002-06-05.

MPP (Massively Parallel Processing) –the coordinated processing of a program by multiple processors that work on different parts of the program, with each processor using its own operating system and memory. Typically, MPP processors communicate using some messaging interface. In some implementations, up to 200 or more processors can work on the same application. An "interconnect" arrangement of data paths allows messages to be sent between processors. Typically, the setup for MPP is more complicated, requiring thought about how to partition a common database among processors and how to assign work among the processors. An MPP system is also known as a "loosely coupled" or "shared nothing" system.
An MPP system is considered better than a symmetrically parallel system (SMP) for applications that allow a number of databases to be searched in parallel. These include decision support system and data warehouse applications. (Whatis.com)

NAS Engine –The controller portion as opposed to the storage portion of a NAS system.

NAS Head –a NAS engine

NAS Gateway –a NAS engine

Network –1. a configuration of data processing devices and software connected for information interchange. 2. A group of two or more computer systems linked together.

Network Attached Storage (NAS) –hard disk storage that is set up with its own network address rather than being attached to the department computer that is serving applications to a network's workstation users. File requests are mapped by the main server to the NAS file server.

Network File System (NFS) – is a client/server application that lets a computer user view and optionally store and update file on a remote computer as though they were on the user's own computer. The user's system needs to have an NFS client and the other computer needs the NFS server. Both of them require that you also have TCP/IP installed since the NFS server and client use TCP/IP as the program that sends the files and updates back and forth. (However, the User Datagram Protocol, UDP, which comes with TCP/IP, is used instead of TCP with earlier versions of NFS.) NFS was developed by Sun Microsystems and has been designated a file server standard. Its protocol uses the Remote Procedure Call (RPC) method of communication between computers.
NFS has been extended to the Internet with WebNFS, a product and proposed standard that is now part of Netscape's Communicator browser. WebNFS offers what Sun believes is a faster way to access Web pages and other Internet files.

Network Operating System (NOS) –software that is used to link files, computers, and other devices over a LAN or WAN.

NIC (Network Interface Card) –a hardware device used to connect computers to a wired or wireless network.

Nonvolatile Memory –a memory that retains information if power is removed and then reapplied. SRAM or static random access memory and flash memory are examples of nonvolatile memory (www.crucial.com)

NUMA (Non-uniform Memory Access) –a method of configuring a cluster of microprocessor in a multiprocessing system so that they can share memory locally, improving performance and the ability of the system to be expanded. NUMA is used in a symmetric multiprocessing (SMP) system. An SMP system is a "tightly-coupled," "share everything" system in which multiple processors working under a single operating system access each other's memory over a common bus or "interconnect" path. Ordinarily, a limitation of SMP is that as microprocessors are added, the shared bus or data path get overloaded and becomes a performance bottleneck. NUMA adds an intermediate level of memory shared among a few microprocessors so that all data accesses don't have to travel on the main bus. NUMA can be thought of as a "cluster in a box." The cluster typically consists of four microprocessors (for example, four Pentium microprocessors) interconnected on a local bus (for example, a Peripheral Component Interconnect bus) to a shared memory (called an "L3 cache") on a single motherboard (it could also probably be referred to as a card). This unit can be added to similar units to form a symmetric multiprocessing system in which a common SMP bus interconnects all of the clusters. Such a system typically contains from 16 to 256 microprocessors. To an application program running

in an SMP system, all the individual processor memories look like a single memory.
When a processor looks for data at a certain memory address, it first looks in the L1 cache on the microprocessor itself, then on a somewhat larger L1 and L2 cache chip nearby, and then on a third level of cache that the NUMA configuration provides before seeking the data in the "remote memory" located near the other microprocessors. Each of these clusters is viewed by NUMA as a "node" in the interconnection network. NUMA maintains a hierarchical view of the data on all the nodes.
Data is moved on the bus between the clusters of a NUMA SMP system using scalable coherent interface (SCI) technology. SCI coordinates what is called "cache coherence" or consistency across the nodes of the multiple clusters.
SMP and NUMA systems are typically used for applications such as data mining and decision support system in which processing can be parceled out to a number of processors that collectively work on a common database. (Whatis.com)

n-Way –multiple way where "n" indicates the number of processors clustered together in a multiprocessing system.

Obsolescent –rating used in this document to classify technologies. The Virginia Enterprise Architecture actively promotes that agencies employ a different technology. Agencies or Central Services Staff should not plan new deployments of this technology. Agencies and Central Services should develop a plan to replace this technology. This technology may be waning in use or no longer supported

PC Card –PCMCIA device or slot.

PCI (Peripheral Component Interconnect) –a standard for connecting peripherals to a personal computer or components within a computer, designed by Intel and released in 1993. PCI is supported by most major manufacturers. The technology is usually called a bus but is in fact a bridge.

PCI Express (PCI X) –developed by the PCI-SIG industry group to extend the PCI bus to meet the present and future computing and communications interconnect requirements, PCI Express is suitable for both chip-to-chip and add-in card implementations. The packetized protocol and layered architecture of the standard enables attachment to copper, optical, or emerging physical signaling media.

PCMCIA (Personal Computer Memory Card International Association) –a PC Card. An international trade association and the standards they have developed for devices, such as modems and external hard disk drives that can be plugged into notebook computers. A PCMCIA card is about the size of a credit card.

Personal Digital Assistant (PDA) –a small hand-held computer typically providing calendar, contacts, and note-taking applications but may include other applications, for example a web browser and media player. Small keyboards and pen-based input systems are most commonly used for user input.

Productivity Software –software typically used by business professionals such as word processing, spreadsheets, presentation slides, web browsers, and plug ins. Also includes lesser used software such as personal database software, flowcharting, project management.
Push Email –email service that sends new email to a device when it is received rather than waiting for the user to request store and forward email.

RAC (Real Application Cluster) –a component of the Oracle 9i database product that allows a database to be installed across multiple servers. According to Oracle, RAC's shared disk method of clustering databases: increases scalability because servers can easily be added or subtracted to meet current needs, lowers costs because companies don't have to buy high-end servers, and improves availability because if one server fails, another can assume its workload. RAC's shared disk architecture is an unusual approach to database clustering. Most competing database products (such as Microsoft's SQL Server and IBM's DB2 for Windows and Unix environments) use the alternative, which is known as "shared nothing" architecture. Shared nothing architecture partitions data and only gives each server access to its own disk subsystem, while shared disk architecture gives all servers access to the entire database. This adds failover capacity to the database, because all servers have access to the whole database. Proponents claim that this capacity increases 9i's reliability and availability significantly. British Telecom, for example, reported that deploying the product enabled them to cut their failover time from a typical 20 minutes to between 10-60 seconds.

RDMA (Remote Direct Memory Access) –a future communications protocol that operates over TCP and

is thus used in conjunction with TCP/IP networks including Ethernet. RDMA is to be implemented in server network interface hardware products that provide RDMA over TCP/IP networks, including Ethernet-based networks.
Networking bandwidths are currently growing faster than the network node's ability to accept the traffic and respond to processing requirements.
Since the RDMA protocol can place data directly into its final memory destination, system processors and memory are available for more useful work. With the improved efficiency and performance of RDMA enabled network interface cards (also called RNICs), applications are better able to scale by sharing tasks across the network as opposed to centralizing work in larger, more expensive systems. More efficient networking also offers the opportunity to converge functions in the data center over fewer types of interconnects. (modified from the RDMA consortium at www.rdmaconsortium.org/).

Redundant Array of Independent Disks (RAID) –a method of organizing small format disk devices to drastically increase I/O bandwidth and improve data availability.

Scale-up server solution –1) from an application perspective, a scale-up solution is one that permits the adding of more resources to the application by adding resources from within a single platform and without increasing the number of operating systems used in supporting the application. 2) for the consolidation of multiple applications, the scale-up solutions will provide the ability to add resources to more than one application from within the platform without increasing the number of operating systems used in supporting the application.

Scale–out server solution–from an application standpoint (e.g., email), the scale-out solution increases resources to the application by adding servers to the cluster of real or virtual servers. The addition of servers increases the number of operating systems supporting the solution.

SCSI –Small Computer System Interface

Secure Digital (SD) –a tiny memory card used to make storage portable among various devices, such as car navigation systems, cellular phones, eBooks, PDAs, smartphones, digital cameras, music players, camcorders, and personal computers. An SD card features a high data transfer rate and low battery consumption, both primary considerations for portable devices. It uses flash memory to provide nonvolatile storage, which means that a power source is not required to retain stored data.
An SD card is about the size of a postage stamp and weighs approximately two grams. It is similar in size to a MultiMediaCard (MMC), but smaller than older memory card types such as the SmartMedia card and the CompactFlash card. Both MMC and SD cards provide encryption capabilities for protected content to ensure secure distribution of copyrighted material, such as digital music, video, and eBooks, but SD cards are available with storage capacities as high as 128MB, with a 512MB SD card expected to be available by late 2002.
SD cards are more rugged than traditional storage media. They have an operating shock rating (basically, the height you can drop them from and still have them work) of 2,000 Gs, compared to a 100-200 G rating for the mechanical drive of the typical portable computing device. This translates to a drop to the floor from 10 feet, as compared to a single foot for the mechanical disk drive. Both MMC and SD cards use metal connector contacts, instead of the traditional pins-and-plugs, so they aren't as prone to damage during handling.
The SD card was jointly developed by Matsushita, SanDisk, and Toshiba.

Serial ATA device (Serial Advanced Technology Attachment or SATA) –a new standard for connecting hard drives into computer systems that is based on serial signaling technology, unlike current IDE (Integrated Drive Electronics) hard drives that use parallel signaling.
SATA has several practical advantages over the parallel signaling (also called Parallel ATA or PATA) that has been used in hard drives since the 1980s. SATA cables are more flexible, thinner, and less massive than the ribbon cables required for conventional PATA hard drives. SATA cables can be considerably longer than PATA ribbon cables, allowing the designer more latitude in the physical layout of a system. Because there are fewer conductors (only 7 in SATA as compared with 40 in PATA), crosstalk and electromagnetic interference (EMI) are less likely to be troublesome. The signal voltage is much lower as well (250 mV for SATA as compared with 5 V for PATA).
SATA creates a point-to-point connection between devices. Transfer rates for SATA begin at 150MBps. One of the main design advantages of Serial ATA is that the thinner serial cables facilitate more efficient airflow inside a form factor and also allow for

smaller chassis designs. In contrast, IDE cables used in parallel ATA systems are bulkier than Serial ATA cables and can only extend to 40cm long, while Serial ATA cables can extend up to one meter. (Combined from Whatis.com and www.techimo.comdefinitions)

SLED –Single Large Expensive Disk

Server Message Block (SMB) –message protocol used by DOS and Windows to share files, directories and devices. (webopedia.com)

Smartcard, also Smart Card –a small electronic device about the size of a credit card that contains electronic memory, and possibly an embedded integrated circuit (IC). Smart cards containing an IC are sometimes called Integrated Circuit Cards (ICCs). Smart cards are used for a variety of purposes, including:
-Storing a patient's medical records
-Storing digital cash
-Generating network IDs (similar to a token)
To use a smart card, either to pull information from it or add data to it, you need a smart card reader, a small device into which you insert the smart card. (webopedia.com)

SMP (Symmetric multiprocessing) –the processing of programs by multiple processors that share a common operating system and memory. In symmetric (or "tightly coupled") multiprocessing, the processors share memory and the I/O bus or data path. A single copy of the operating system is in charge of all the processors. SMP, also known as a "shared everything" system, does not usually exceed 16 processors.
SMP systems are considered better than massively parallel processing (MPP) systems for online transaction processing (OTP) in which many users access the same database in a relatively simple set of transactions. An advantage of SMP for this purpose is the ability to dynamically balance the workload among computers (and as a result serve more users faster).

SMT –simultaneous multithreading.
Simultaneous multithreading is a processor design that combines hardware multithreading with superscalar processor technology to allow multiple threads to issue instructions each cycle. Unlike other hardware multithreaded architectures (such as the Tera MTA), in which only a single hardware context (i.e., thread) is active on any given cycle, SMT permits all thread contexts to simultaneously compete for and share processor resources. Unlike conventional superscalar processors, which suffer from a lack of per-thread instruction-level parallelism, simultaneous multithreading uses multiple threads to compensate for low single-thread ILP. The performance consequence is significantly higher instruction throughput and program speedups on a variety of workloads that include commercial databases, web servers and scientific applications in both multiprogrammed and parallel environments. (http://www.cs.washington.edu/research/smt/index.htm)

SmartMedia –a card (originally called a solid-state floppy disk card, or SSFDC) is a memory card developed by Toshiba that uses flash memory to store data and to make it portable among devices, such as digital cameras, personal digital assistants (PDAs), and other handheld devices. At 45 X 37 mm and less than 1 mm thick (about as big as a matchbook), SmartMedia is similar in size to the CompactFlash card (although significantly thinner), but larger than the newer, postage stamp-sized alternatives, MultiMediaCard and Secure Digital (SD card). SmartMedia cards are available with storage capacities ranging up to 128MB, with higher capacities corresponding to higher prices.
Unlike CompactFlash, SmartMedia doesn't have an on-board controller. Compliant devices have a controller built into the units' slots.
The main advantage that SmartMedia cards have over the other memory cards is that because they read, write, and erase memory in small blocks of data (256 or 512 bytes at a time), you can more precisely select what data you want to save. However, SmartMedia cards aren't as sturdy as the other formats, and so require more careful handling and storage.

Snapshot – a backup facility provided by several companies. For example:
1.) A function of Tivoli Storage Management (TSM) that backs up the entire TSM database to media that can be taken off-site. The database snapshot does not interrupt any database backup series and cannot have incremental database backups associated with it. (Tivoli.com)
2.) SNAZ InstaView™ is optional Snapshot Software available with SNAZ SVA. SNAZ InstaView provides point-in-time volume imaging and presents a virtually unlimited number of views of the data. Each view can be individually allocated, on a read only or read/write basis, to any server. Data replication and data rollback are also offered as part

of SNAZ InstaView functionality. Key benefits of SVA InstaView include:
- Backup and operations can be completed in background while volumes remain on-line
- Multiple views can be created and accessed simultaneously without copying data. There is no need to replicate data for each view, saving significant amount of storage and improving performance
- Ability to maintain several versions of data
- Ability to run several applications in parallel, using the same data
- Ability to create a view of the data at any specific time for later use (www.snia.org)

SNIA –Storage Network Industry Association www.snia.org

Snooping –when multiple processors with separate caches share a common memory, it is necessary to keep the caches in a state of coherence by ensuring that any shared operand that is changed in any cache is changed throughout the entire system. This is done in either of two ways: through a directory-based or a snooping system. In a directory-based system, the data being shared is placed in a common directory that maintains the coherence between caches. The directory acts as a filter through which the processor must ask permission to load an entry from the primary memory to its cache. When an entry is changed the directory either updates or invalidates the other caches with that entry. In a snooping system, all caches on the bus monitor (or snoop) the bus to determine if they have a copy of the block of data that is requested on the bus. Every cache has a copy of the sharing status of every block of physical memory it has.

Synchronous Optical Network (SONET) –a standard format for transporting a wide range of digital telecommunications services over optical fiber. SONET is characterized by standard line rates, optical interfaces, and signal formats.

Storage Area Network (SAN) –a storage model typically characterized by a use of switching and transmission facilities that are separate from the local area network where the server of data to be stored and retrieved resides. As IP and Ethernet protocols become used in SANs, the model and/or name may change.

Strategic –a technology or protocol rating used in this document. Ratings of strategic instruct agencies as follows: " The Virginia Enterprise Architecture promotes use of this technology by agencies. New deployments of this technology are recommended."

Subscriber Identification Module Card (SIM Card) –a card commonly used in a GSM phone. The card holds a microchip that stores information and encrypts voice and data transmissions, making it close to impossible to listen in on calls. The SIM card also stores data that identifies the caller to the network service provider. (http://www.teletractor.com/mobilecomms/glossary.htm#S)

Super Digital Linear Tape (SDLT) –a variant of DLT technology, called SuperDLT, makes it possible to store upwards of 100 GB on a single cartridge. The SuperDLT drive can transfer data at speeds of up to 10 megabytes per second (Mbps). (searchStorage.com)

Switch –network device that filters, forwards, and floods frames based on the destination address of each frame. The switch operates at the data link layer of the OSI model. A fabric switch may have significant management and security functionality in addition to switching protocol choices. (modified Cisco definition)

Synchronous –this term has two distinct meanings in networking: 1.) a network communication, which requires a reply for completion or 2.) a type of network transmission that uses start and stop bits to establish precise clocking.

Sysplex (from System and Complex) –a computer image that consists of the multiple computers (the systems) that make up the complex. A sysplex is designed to be a solution for business needs involving any or all of the following: parallel processing; online transaction processing (OLTP); very high transaction volumes; very numerous small work units - online transactions, for example (or large work units that can be broken up into multiple small work units); or applications running simultaneously on separate systems that must be able to update to a single database without compromising data integrity. According to IBM, the Parallel Sysplex is the end result of IBM large systems' developments over the years, from the single system uniprocessor, to tightly-coupled multiprocessors, to loosely-coupled configurations, to the sysplex, and finally to the Parallel Sysplex. A single system uniprocessor consists of a single central processor complex (CPC) - which consists of a single central processor (CP)

and all associated system hardware and software, controlled by a single copy of the operating system. Tightly coupled multiprocessors consist of a number of CPs added to a CPC that share central storage and a single copy of the operating system. Work is assigned to an available CP by the operating system and can be rerouted to another if the first CP fails. A loosely coupled configuration has multiple CPCs (which may be tightly coupled multiprocessors) with separate storage areas, managed by more than one copy of the operating system and connected by channel-to-channel communications.
A sysplex is similar to a loosely coupled configuration, but differs in that it has a standard communication mechanism (the cross-system coupling facility, or XCF) for MVS system applications that enables communication between application programs on one or multiple computers. The sysplex is made up of a number of CPCs that collaborate, through specialized hardware and software, to process a work load. This is what a large computer system does in general; a sysplex, through XCF, increases the number of processing units and operating systems that can be connected.
The Parallel Sysplex, IBM's latest method of configuration for CPCs, is a clustering architecture that has improved communication capabilities and supports more connected CPCs and more copies of the operating system. There are several areas of improvement over the base sysplex. The Parallel Sysplex Coupling Facility is a new processor that stores crucial system information, usually configured on a separate device. Use of the coupling facility increases the capacity for data sharing among systems and subsystems. Because it is used through both systems and subsystems, it also ensures data integrity and consistency throughout the sysplex. Another feature of the new technology is the Workload Manager (WLM), part of OS/390 that is in each system in a Parallel Sysplex configuration. WLM manages resources more responsively than the earlier schedule-based methods through dynamic workload balancing and prioritization according to user-set criteria. The data-sharing capability enables simultaneous, multiple-system access to data. (Whatis.com)

System Image –the current contents of memory, which includes the operating system and running programs. For effective management, a cluster of computer systems may be organized as a single system image, in which all systems appear as one. See virtual server and Sysplex.

Tape Library, Automated (ATL) –a robotic media handler capable of storing multiple pieces of removable media and loading and unloading them from one or more drives in arbitrary order.

Tape Silo –Tape Library, Automated

Transitional –rating used in this document to classify technologies. The Virginia Enterprise Architecture promotes other standard technologies. Agencies may be using this technology as a transitional strategy in movement to a strategic technology. This technology may be waning in use or no longer supported.

Utility Service –In this report, the term is used to connote a function or activity typically provided in-house by an IT unit, which may be separated from IT work requiring business knowledge, and which may be provided by a central enterprise service (in-sourced) or by an external business (outsourced). An example would be web site hosting. You can provide server space and accessibility levels without knowing the business of the agency or the content of the website.

Virtual Machine –A software emulation of a physical computing environment.
The term gave rise to the name of IBM's VM operating system whose task is to provide one or more simultaneous execution environments in which operating systems or other programs may execute as though they were running "on the bare iron", that is, without an enveloping Control Program. A major use of VM is the running of both outdated and current versions of the same operating system on a single CPU complex for the purpose of system migration, thereby obviating the need for a second processor. (FOLDOC)

Virtual Host –1) On the Web, a server that contains multiple Web sites, each with its own domain name. As of the first version of the Web protocol (HTTP 1.0), each Web site on a virtual host must be assigned a unique IP address. HTTP Version 1.1 eliminates this requirement. See also virtual server.

Virtual Server –1a) Same as virtual host. (http://content.techweb.com/encyclopedia/) 1b) 3. A configuration of a World-Wide Web server that appears to clients as an independent server but which is actually running on a computer that is shared by any number of other virtual servers. Each virtual

server can be configured as an independent web site, with its own hostname, content, and security settings. The Domain Name System or DNS maps the hostnames of all virtual servers on one physical server to its IP address. The web server software then uses the "Host" header in the HTTP request to determine which virtual server the request was for, and then processes the request using that virtual server's configuration. (foldoc.org) 2) Multiple servers that appear as one server, or one system image, to the operating system or for network administration. (http://content.techweb.com/encyclopedia/)

Virtual Storage –the storage space that may be regarded as addressable main storage by the user of a computer system in which virtual addresses are mapped into real addresses. The size of virtual storage is limited by the addressing scheme of the computer system and by the amount of auxiliary storage available, not by the actual number of main storage locations. (www.ibm.com)

Virtual Tape –virtual tape is the use of a special storage device that manages less-frequently needed data so that it appears to be stored entirely on tape cartridges when some parts of it may actually be located in faster, hard disk storage. The programming for a virtual tape system is sometimes called a virtual tape server (VTS). Virtual tape can be used with a hierarchical storage management (HSM) system in which data is moved as it falls through various usage thresholds to slower but less costly forms of storage media. Virtual tape may also be used as part of a storage area network (SAN) where less-frequently used or archived data can be managed by a single virtual tape server for a number of networked computers.
A virtual tape system offloads from the main computer the processing involved in deciding whether data should be available in the faster disk cache or written onto a tape cartridge. The virtual tape system also can manage data so that more of the space on a tape cartridge is actually used. (searchStorage.com)
IBM and Storage Technology are well-established vendors of virtual tape systems. Sutmyn Storage sells a product that provides a virtual interface to existing IBM and other systems.

Virginia Information Technologies Agency (VITA) –a merged technology agency created by Virginia's 2003 General Assembly.

Wide Area Network (WAN) –1) A network that provides communication services to a geographic area larger than that served by a local area network or a metropolitan area network, and that may use or provide public communication facilities. A WAN typically consists of multiple LANs that are linked together. 2) A data communications network designed to serve an area of hundreds or thousands of miles; for example, public and private packet-switching networks, and national telephone networks. 3) A computer network that links multiple workstations and other devices across a large geographical area.

WiFi (Wireless Fidelity) –a protocol specified in 802.11b from the Institute of Electrical and Electronics Engineers (IEEE), which is part of a series of wireless specifications together with 802.11, 802.11a, and 802.11g. WiFi refers to an over-the-air connection with a wireless client and a base station or between two wireless clients.

WORM –write once read many times medium.

Information provided in Virginia's Enterprise Architecture Glossaries are liberally borrowed from a number of Internet sources including the following highly recommended general sources:

- O'Reilly's (search box at the bottom of the page) http://www.oreilly.com/reference/dictionary/tsearch.cgi
- What Is? http://whatis.techtarget.com/
- Cisco's Glossary of LAN terms http://www.cisco.com/univercd/cc/td/doc/product/lan/trsrb/glossary.htm
- MobilInfo.Com Glossary http://www.mobileinfo.com/Glossary/
- Free Online Dictionary Of Computing http://foldoc.doc.ic.ac.uk/foldoc/index.html
- TechWeb's Encyclopedia http://content.techweb.com/encyclopedia/

Numerous other authoritative sources have been referenced because of their special expertise in specific areas of technology.

Appendices

(This page is blank, intentionally.)

Appendix A: Operating Systems in non-Higher Education Executive Branch Agencies

Software Type	Count
OS - AIX	25
OS - ATT UNIX	42
OS - HPUX	23
OS - Linux	81
OS - MPE	9
OS - MVS	1
OS - Novell Netware 3.x	8
OS - Novell Netware 4.x	112
OS - Novell Netware 5.x	92
OS - Novell Netware 6.x	13
OS - NT 4 Server	824
OS - Open VMS	14
OS - OS2	2
OS - OS400	1
OS - Solaris	128
OS - UNIX	9
OS - VM	1
OS - VMS	10
OS - Windows 2000 Advanced	100
OS - Windows 2000 Server	732

Due Diligence Data, FY2003 (October)

Appendix B: Platform Domain Team Analysis of Technology Trends, Enterprise Business Strategies and Requirements for Technical Architecture

Technology Trends

The Enterprise Architecture (EA) Workgroup identified the technology trends presented in Table B-1 in FY 2003. The EA Workgroup believes these technology trends to be the most significant trends for influencing how the Commonwealth will accomplish its important business goals and objectives over the next two to three biennia. The actual impact of any given trend will be constrained heavily by the ability of IT and business managers to make a strong case for acceptable returns on investments for implementing new technologies that may result from these trends.

Table B-1: Critical Technology Trends Identified by the EA Workgroup
Note: these trends were developed by the Council on Technology Services (COTS) Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

	Trends	Platform Impact
1.	Development and Use of Improved Communications Solutions	High
2.	Technology Improvements Support Growing Security Emphasis	High
3.	Improved Solutions for Escalating Storage Needs	High
4.	Migrations from UNIX (low end) Predicted	High
5.	Web Services Maturation Anticipated	Medium
6.	Systems Management Tools Maturation Anticipated	Medium
7.	More Cost-Effective Outsourcing Opportunities Expected	High
8.	Better Enterprise Commercial-Off-the-Shelf (COTS) Solutions Available for Government	Low
9.	Content Management Systems are Improving	Low

Table B-1: Critical Technology Trends Identified by the EA Workgroup
Note: these trends were developed by the Council on Technology Services (COTS) Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

	Trends	Platform Impact
10.	Increased architectural penetration of XML solutions.	High

The Platform domain architecture team considered the EA Workgroup trends and also identified additional domain specific trends that they believe will influence platform architectural recommendations. The right column of Table B-1 presents the platform domain team's assessment of the relative impact of EA Workgroup trends on the Commonwealth's future platform architecture.

Table B-2 presents the domain-specific technology trends that the Platform Domain team feels will shape personal computing, server and storage architecture in the future.

Table B-2: Platform Specific Trends Identified by the Domain Team
Note: these trends were developed by the COTS Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

	Trends	Platform Impact
11.	Personal Computing: The desktop, notebook, pen tablet, and PDA will converge in capabilities.	High
12.	Personal Computing: The convergence of voice, video, and data will shape future platforms.	High
13.	Personal Computing: Platforms of the future will accommodate mobility needs as a standard feature.	High
14.	Personal Computing: Personal computers will be used for voice communications.	High
15.	Servers: Greater use of dense solutions (e.g., blades, virtual servers) whenever they are an appropriate option	High

Table B-2: Platform Specific Trends Identified by the Domain Team

Note: these trends were developed by the COTS Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

	Trends	Platform Impact
16.	Servers: Escalating capabilities of servers enable moving applications downward (e.g., High-end UNIX systems approaching mainframes in capability).	High
17.	Servers: Greater use of Linux by businesses, especially foreign businesses	Medium (note lawsuit)
18.	Servers: Linux utility moving towards high end applications	Medium (note lawsuit)
19.	Servers: Redeployment of hardware by changing uses and operating systems	Medium
20.	Servers: Planners are exploring consolidation opportunities, especially hardware consolidation.	High
21.	Storage: Movement from DAS to NAS	Medium
22.	Storage: Convergence of SAN and NAS.	Medium
23.	Storage: Storage moving from an application service to a system-wide utility.	High
24.	Storage: Changes in connectivity options will speed convergence of storage models.	High

Platform Domain Team's Analysis of Enterprise Business Strategies

In FY 2003, the EA Workgroup identified five high-level business drivers and 24 specific strategies or activities to address these drivers. Both the drivers and the strategies were developed prior to the release of the Secretary of Technology's strategic plan, but they are very much in line with the Secretary's focus on centralized services, planning and tracking IT expenditures, managing IT activities, promoting R&D, deploying broadband, and promoting technology–based economic development in his strategic plan. Table B-3 provides the drivers and Table B-4 provides the specific activities and their tie-in to the Secretary's strategic plan. Activities that have a significant impact on the platform architecture are listed first.

Table B3: Enterprise Business Drivers in Brief

Note: these business strategy driver categories were developed by the COTS Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

1.	Meet the Access Needs of Citizens
2.	Improve Efficiency and Effectiveness of Government Services
3.	Make Security Program Improvements
4.	Improve IT Services for Agencies/Workforce
5.	Support Virginia's Economic Development

Because it is crucial that the platform architecture supports any platform change requirements implied by these critical strategies, the domain team carefully appraised the impact each strategy might have on the overall platform architecture.

- H High Impact—these strategies have significant potential for requiring near-term and/or long-range changes in platform infrastructure
- M Medium Impact—these strategies influence some aspect of platforms used for business or personal computing
- L Low Impact—these strategies make relatively few, if any, demands on the platform infrastructure

Table B3: Enterprise Business Strategies (EBS) and Perceived Platform Impact

Note: these EBS examples were developed by the COTS Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

Fit with Secretary's Strategic Focus	Enterprise Business Strategies EBS	Business Change BC and Business Information Requirements BIR	Likelihood that addressing strategy will require a change in Platform Architecture: Personal Computing	Server	Storage
–Plan/Track –Centralize	**EBS 5:** Employ new technologies as soon as effectiveness and efficiencies are confirmed.	BC-Organization/ Staff; Communications BIR-New planning information: technology cost and benefit information	L	M	L
–Plan/Track –Centralize	**EBS 7:** Use outsourcing whenever efficiencies can be realized and quality maintained.	BC-Organization/ Staff BIR-New planning information: alternatives, costs and benefits; information on connectivity requirements.	M	M	L
–Plan/Track –Centralize –Manage	**EBS 8:** Make enterprise services improvements (HR, accounting, and budgeting systems).	BC-Organization BIR-New planning information: needs, benefits, costs	L	H	L
–Centralize	**EBS 10:** Share technical staff expertise across agency and political boundaries	BC-Funding & cost allocation expertise; some legislative/ funding changes BIR-New planning information: human resources and skills available; locations of resources and needs.	H	H	H
–Customer –Centralize	**EBS 14:** Establish minimum, standard tools/services for workers (e.g., desktops, help desk services, communications, productivity software profiles).	BC-Organization/ Staff; standards; centralization BIR-Planning information: inventory and needs; procurement data; outsourcing cost analyses	H	L	L
–Plan/Track –Centralize	**EBS 17:** Centralize software licenses and information about software needs.	BC-Organization/ Staff BIR-Planning information: procurement timing; license data and licensing trends; resource management; change management.	H	M	L

Table B3: Enterprise Business Strategies (EBS) and Perceived Platform Impact

Note: these EBS examples were developed by the COTS Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

Fit with Secretary's Strategic Focus	Enterprise Business Strategies EBS	Business Change BC and Business Information Requirements BIR	Likelihood that addressing strategy will require a change in Platform Architecture: Personal Computing	Server	Storage
–Centralize –Economic Develop-ment	**EBS 18:** Reduce the duplication of resources (e.g., by establishing service bureaus like payroll and VIPNet or by acquiring central resources).	BC-Organization/ Staff. BIR-Planning information: data on duplication; data on service needs. Change management.	H	H	H
–Manage	**EBS 19:** Effect improvements in the management of all IT systems and IT resources (e.g., provide standard management tools, training, and expectations).	BC-Organization/ Staff BIR-Planning information: technology management strategy costs and benefits. Evaluation/audit information.	M	H	H
–Centralize	**EBS 21:** Provide centrally approved security protections for all central systems.	BC-Organization/ Staff BIR-Planning information: as is architecture of central administrative systems	H	H	H
–Customer	**EBS 24:** Enable ease of access to online services (e.g., MyVAPin for single sign on to Web accessible services)	BC-New shared applications and infrastructure BIR-Authentication and authorization information; systems interconnection information; system failure information (metrics)	L	M	L
–Centralize –Manage	**EBS1:** Produce data needed for improved decision-making (e.g., data about resources and needs for use in contract negotiation and resource allocation).	BC-Organization/ Staff BIR-New planning information: resources and needs	L	L	L
–Centralize	**EBS 2:** Improve risk management (e.g., offer central analysis tools)	BC-Acquire new tools; provide new training BIR-New planning information: risk assessment and analysis	L	L	M

Table B3: Enterprise Business Strategies (EBS) and Perceived Platform Impact

Note: these EBS examples were developed by the COTS Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

Fit with Secretary's Strategic Focus	Enterprise Business Strategies EBS	Business Change BC and Business Information Requirements BIR	Likelihood that addressing strategy will require a change in Platform Architecture: Personal Computing	Server	Storage
–Centralize –Manage	**EBS 3:** Improve management of IT projects and programs (e.g., provide common methodology; provide information; provide training; improve IT lifecycle management through use of metrics)	BC-Organization/ Staff BIR-New planning information: audit/evaluation results and training tracking	L	L	L
–Plan/Track	**EBS 4:** Track IT costs and savings.	BC-Change chart of accounts, budgeting, funding, procurement. BIR-New evaluation information; New planning information	L	L	L
–Plan/Track –Centralize –Manage	**EBS 6:** Use alternate financing opportunities to pursue IT efficiencies when solutions require high front-end costs to achieve a proven ROI.	BC-Organization/ Staff; Legislation BIR-New planning information: costs and benefits; evaluation data; tracking/ accounting	L	L	L
–Plan/Track –Centralize	**EBS 9:** Erase political and technical boundaries between agencies and between localities to pursue cooperative/ consolidated resource use.	BC-funding & cost allocation expertise; some legislative/funding changes BIR-New planning information; resource use information	L	L	L
–Customer	**EBS 11:** Share procurement decision and analysis information with business assistance and chamber of commerce organizations via the Virginia Economic Development Partnership (VEDP).	BC-activity BIR-New analytic information: procurements	L	L	L
–Customer	**EBS 12:** Share government skill shortage analysis information through VEC, high schools, colleges.	BC-activity BIR-Analytic information: Skills	L	L	L

Table B3: Enterprise Business Strategies (EBS) and Perceived Platform Impact

Note: these EBS examples were developed by the COTS Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

Fit with Secretary's Strategic Focus	Enterprise Business Strategies EBS	Business Change BC and Business Information Requirements BIR	Likelihood that addressing strategy will require a change in Platform Architecture		
			Personal Computing	Server	Storage
–Customer –Centralize	**EBS 13:** Provide central security resources, training, and incident reporting capabilities (e.g., through a Chief Security Officer's (CSO) office).	BC- Legislative change or funding & cost allocation expertise BIR-Planning information: needs, benefits, costs	L	L	L
–Customer	**EBS 15:** Address multiple access type needs of citizens for services and information (e.g., mobile, from home, at service center, in person)	BC-Application scope BIR-Planning information: customer needs; solutions	L	L	L
–Customer	**EBS 16:** Pursue information accessibility improvements (e.g., Web information management/content management)	BC-application scope BIR-Planning information: current accessibility; track improvements	L	L	L
–Centralize	**EBS 20:** Implement standards driven security program improvements within agencies.	BC-Organization/ Staff BIR-Planning information: security audit; security training; outsourcing cost analyses.	L	L	L
–Plan/Track –Customer	**EBS 22:** Coordinate administrative systems improvement efforts.	BC-Organization/ Staff; database keys control across systems BIR-Planning information: decision and evaluation data; cost data	L	L	L
–Customer	**EBS 23:** Improve Internet provision of customer service	BC-Application scope BIR-Information on opportunities; progress	L	L	L

Platform Domain Team Analysis of Requirements for Technical Architecture

The EA Workgroup, by delineating information requirements related to the identified business strategies discussed above, developed a list of specific requirements for technical architecture. These requirements were assessed by the platform domain team for potential for impact on the platform architecture. The results are provided in Table B-4 below.

Table B4: Requirements for Technical Architecture

Note: these RTA address the EBS developed by the COTS Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

Requirements for Technical Architecture	Platform Impact
RTA 1: The Enterprise Architecture must enable the capture of trends over time from central human resource systems and procurement systems	Medium
RTA 2: The Enterprise Architecture must enable the creation of smaller, effort-specific databases that may be easily integrated with enterprise information	Low
RTA 3: The Enterprise Architecture must enable collaborative access to online data, information, and training materials by agencies	High
RTA 4: The Enterprise Architecture must enable new and improved methods of "from the field" collection and entering of data	Low
RTA 5: The Enterprise Architecture must enable the secure sharing of planning data across agencies	Low
RTA 6: The Enterprise Architecture must enable the analysis and testing of new technologies in special environments when appropriate	High
RTA 7: The Enterprise Architecture must enable the integration of function or decision specific HR information with information already available in the enterprise human resource systems	Medium
RTA 8: The Enterprise Architecture must enable increased development and sharing of information.	High
RTA 9: The Enterprise Architecture must enable the tracking of bandwidth usage for billing agencies/funds for use of shared pipes.	Low
RTA 10: The Enterprise Architecture must employ database/data warehouse technologies for current and past information about licenses, hardware, and software under agency and central control to enable coordination of software license and platform selection decisions.	Medium
RTA 11: The Enterprise Architecture must enable establishing, implementing and tracking worker desktop tools (hardware and software) and service level (e.g., help desk, network/Internet access) minimums/standards	Medium

Table B4: Requirements for Technical Architecture

Note: these RTA address the EBS developed by the COTS Enterprise Architecture workgroup for inclusion in the next revision of the Common Requirements Vision.

Requirements for Technical Architecture	Platform Impact
RTA 12: The Enterprise Architecture must enable increased use of mobile connectivity (e.g., middleware)	High
RTA 13: The Enterprise Architecture must enable improved Web content management and portal services	Low
RTA 14: The Enterprise Architecture must enable greater integration of central application systems for addressing priority information access needs enterprise-wide (e.g., middleware, controlled foreign keys, selected system replacements)	Low
RTA 15: The Enterprise Architecture must enable ease of integration of agency systems with central systems when central systems cannot cost-effectively provide for all agency needs).	Medium
RTA 16: The Enterprise Architecture must enable speedy, highly secure, 24x7 authentication, authorization, update, and access coordination with applications of multiple agencies.	Medium
RTA 17: The Enterprise Architecture must enable 24x7 citizen helpdesk.	Medium
RTA 18: The Enterprise Architecture must enable reliable, fail safe operations.	High